AGENCY APPROVAL DRAFT

Subsurface Sediment Coring Field Sampling Plan

Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling

Portland Harbor Superfund Site

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Prepared for:

United States Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101

On behalf of:

Portland Harbor Pre-RD AOC Group
Portland, Oregon

Prepared by:

AECOM

111 SW Columbia, Suite 1500
Portland, OR 97201
USA

Geosyntec consultants

520 Pike Street, Suite 1375
Seattle, WA 98101
USA

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kenneth Tyrrell

April 3, 2018

Kenneth M. Tyrrell
PDI Project Coordinator
AECOM Technical Services

Date

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
AECOM	AECOM Technical Services
ALS	ALS Environmental
Alt F Mod	Alternative F Modified SMA footprint
Anchor	Anchor Environmental LLC
ASAOC	Administrative Settlement Agreement and Order on Consent
ASTM	American Society for Testing and Materials
bml	below mudline
COCs	contaminants of concern
CRD	Columbia River Datum
CSM	Conceptual Site Model
D/F	dioxin/furans
D/U Reach	Downtown/Upriver Reach
DDT	dichlorodiphenyltrichloroethane
DDx	DDT and its derivatives
DGPS	differential global positioning system
DQMP	Data Quality Management Plan
DQOs	Data Quality Objectives
EPA	United States Environmental Protection Agency
FC	Field Coordinator
FMD	future maintenance dredge area
FS	feasibility study
FSP	Field Sampling Plan
ft	foot/feet
ft/lbs	feet per pound
Geosyntec	Geosyntec Consultants, Inc.
GIS	geographic information system
Gravity	Gravity Marine Services
ID	identification number
IDW	investigation-derived waste
Integral	Integral Consulting, Inc.
LWG	Lower Willamette Group
MHW	mean high water
NAD83 (2011)	North American Datum of 1983 National Adjustment of 2011
NAPL	non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988

PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PDI	Pre-Remedial Design Investigation
PHSS	Portland Harbor Superfund Site
PID	photoionization detector
PRD	Portland River Datum
Pre-RD AOC Group	Pre-Remedial Design Agreement and Order on Consent Investigation Group
Pre-RD	Pre-Remedial Design
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAL	remedial action level
RI	remedial investigation
RM	river mile
ROD	Record of Decision
SC	sediment core
Site	Portland Harbor Superfund Site
SMA	sediment management area
SOPs	Standard Operating Procedures
SOW	Statement of Work
SPCS	State Plane Coordinate System
TestAmerica	TestAmerica Laboratories
TOC	total organic carbon
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

1. INTRODUCTION

The Record of Decision (ROD) described a post-ROD sampling effort for the Portland Harbor Superfund Site (Site or PHSS; Figure 1) located in Portland, Oregon, to delineate and better refine the sediment management area (SMA) footprints, refine the Conceptual Site Model (CSM), determine baseline conditions, and support remedial design (United States Environmental Protection Agency [EPA] 2017a). Geosyntec Consultants, Inc. (Geosyntec), and AECOM Technical Services (AECOM) submitted a detailed Work Plan for Pre-Remedial Design Investigation and Baseline Sampling (PDI) on behalf of a group of industrial parties called the Pre-Remedial Design Agreement and Order on Consent Investigation Group (Pre-RD AOC Group). On December 19, 2017, EPA entered into an Administrative Settlement Agreement and Order on Consent (ASAOC) with the Pre-RD AOC Group to conduct the PDI studies at the Site (EPA 2017b). The ASAOC includes a Statement of Work (SOW) and the PDI Work Plan (as an attachment to the SOW), which generally describe the agreed upon field investigation activities, data analyses, schedule, and deliverables for the PDI.

These PDI studies are a foundational step in what will be a multi-phase effort to update current conditions from the collection of data during the remedial investigation (RI)/feasibility study (FS). The RI/FS was initiated by a group of potentially responsible parties known as the Lower Willamette Group (LWG) and completed by EPA in 2016 (EPA 2016a, 2016b). The RI consisted of three rounds of data collection, including surface and subsurface sediment, shoreline/nearshore soils, surface water, sediment traps, porewater, fish tissue, and other media from 2001 through 2007.

This Field Sampling Plan (FSP) was prepared to support the subsurface sediment sampling outlined in the PDI Work Plan (Geosyntec 2017) and the project Quality Assurance Project Plan (QAPP) (AECOM and Geosyntec 2018a). To the extent practicable, previously approved FSPs and standard operating procedures (SOPs) from the RI will be referenced.

1.1 Project Setting

The PHSS is located in Portland, Oregon, on the lower Willamette River immediately downstream of the urban downtown area from river mile (RM) 1.9 upstream to 11.8 and covers 2,190 acres. There are two reaches located immediately upstream of the Site. The Downtown Reach, which includes the urbanized area of downtown Portland, is defined by EPA as extending from RM 11.8 to RM 16.6. EPA defines the Upriver Reach as extending from RM 16.6 to RM 28.4. Collectively, RM 11.8 to RM 28.4 is referred to as the Downtown/Upriver Reach (D/U Reach).

The bathymetry elevation for most of the Site is from -30 to -50 feet (ft) Columbia River Datum (CRD) and is dominated by the authorized federal navigation channel (EPA 2017a). This channel, extending nearly bank-to-bank in some areas, doubles the natural depth of the river and allows transit of large ships into the active harbor; the PHSS serves as a major shipping route for containerized and bulk cargo. Elevations in the federal navigation channel are generally -40 to -50 ft CRD, and the authorized depth is -40 ft CRD (or about -35 ft North American Vertical Datum of 1988 [NAVD88]). The CRD vertical datum is used by the United States Geological Survey (USGS) and United States Army Corps of Engineers (USACE); however, the primary vertical datum used for the PDI studies will be NAVD88.[1] The USGS gauging stations is located at the Morrison Bridge at RM 12.8; river levels recorded by that gauge are reported in Portland River Datum (PRD). Additional shipping and berthing areas were identified in the ROD as future maintenance dredge (FMD) areas with potential maintenance dredging requirements.

The remedy selected in the ROD (EPA 2017a), called the Alternative F Modified SMA footprint (Alt F Mod), identified 394 acres of engineered remediation with a combination of remedial technologies. The PDI subsurface sediment sampling activities are focused on refining the horizontal and vertical extent of contamination in these areas, especially the SMA areas targeted for dredging or partial dredging/capping. A total of 90 PDI cores are proposed to reduce this uncertainty. In addition, a surface sediment grab sample will be collected from each deep, in-water core location per protocols outlined in the Surface Sediment Sampling FSP.

Subsurface sediment samples will be analyzed for the focused contaminants of concern (COCs), which include dichlorodiphenyltrichloroethane (DDT) and its derivatives (DDx), polychlorinated biphenyls (PCBs, as Aroclors), polycyclic aromatic hydrocarbons (PAHs), and dioxin/furans (D/F).

1.2 Data Quality Objectives

Data Quality Objectives (DQOs) for subsurface sediment sampling are detailed in Table 3 of the project QAPP and are consistent with the PDI Work Plan (Geosyntec 2017). Criteria for acceptable laboratory quality assurance/quality control (QA/QC) are described in Section 3.3 of the project QAPP, and the analytical suite for the samples is presented in Table 2a in the project QAPP (AECOM and Geosyntec 2018a). As stated in the PDI Work Plan (attached to the ASAOC), the goal of the subsurface sampling effort is to refine the horizontal and vertical extent of contamination greater than the remedial action levels (RALs) at depth for the purpose of supporting the 30% design, to refine the CSM for remedial design purposes, and to refine the dredge volumes for 30% design cost estimation.

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[1] CRD is used as the nautical chart datum for the lower Willamette River, using a reference plane established by the USACE in 1912. Because this datum is based on water elevations throughout the river, CRD is not a fixed/level datum but slopes upward as one moves upstream. Therefore, the NAVD88 fixed vertical datum will be the primary datum used in the PDI studies. The difference between the two datums is about 5.2 vertical ft within the Site. For reference, at RM 1.3 the difference is 5.4 ft, and at RM 12.8 the difference is 4.6 ft.

2. SAMPLING DESIGN AND APPROACH

A total of 90 core locations, presented in Figures 2a through 2f, have been selected for the PDI study to refine the spatial extent (horizontal and vertical) of the Alt F Mod active SMA remedial footprint. Methods for subsurface sediment sampling are generally consistent with EPA-approved sampling plans from the RI (Integral Consulting, Inc. [Integral] 2002, 2004, 2006), EPA guidance on collecting and processing sediment data (EPA 2014), and Puget Sound Estuary Program (PSEP) protocols (PSEP 1986).

2.1 Previous LWG RI/FS Subsurface Sediment Coring

The LWG completed three rounds of field sampling between 2002 and 2008 for the RI/FS. Subsurface sediment core sampling is summarized below.

- Subsurface samples were collected during the Round 2 field sampling event (2004-2005) in two phases: Round 2A and Round 2B (Integral and Anchor Environmental LLC [Anchor] 2005; Integral 2005).
    - During Round 2A coring between September and November 2004, a total of 218 cores were collected from 200 locations within RM 2 and RM 10. A total of 717 subsurface sediment samples were submitted for laboratory analyses.
    - During Round 2B coring in October 2005, a total of 181 subsurface samples were collected from 42 locations between RM 3.5 to RM 10.
- Subsurface sediment samples were collected during the Round 3 field sampling event (2007-2008) in two phases: Round 3A and Round 3B (Integral 2007, 2008).
    - During Round 3A coring in January and February 2007, subsurface samples were collected upstream between RM 9.5 and RM 12 and downstream of the Site between RM 0.9 and RM 1.9. A total of 24 sediment cores were collected from 18 locations in the upstream and downstream reaches combined, and 106 subsurface sediment samples were submitted for laboratory analyses.
    - During Round 3B coring between November 2007 and January 2008, a total of 94 subsurface cores were collected from 88 locations within three reaches: 1) the Site and slightly upriver of the Site between RM 2 and RM 12.2; 2) the upper reach of the Multnomah Channel; and 3) upriver between RM 15.3 and RM 26. A total of 244 subsurface sediment samples were submitted for laboratory analyses.

Post RI/FS sampling was conducted by multiple parties along the Willamette River between RM 1.9 and RM 11.8. These investigations were supplementary to the RI/FS and are discussed in the PDI Work Plan. Details on core locations were not available for many of these studies, and they were not used in locating cores for this PDI. As additional details on these post-RI/FS studies become available, information will be included in the data analysis and reporting phases.

2.2 Sediment Core Location Rationale

Proposed and historical core locations are presented in Figures 3a through 3h. Placement of the 90 proposed core locations were based on the visual assessment of subsurface contamination using 250- to 300-ft distance as a general guidance to the next nearest coring location. In some cases, stations will be re-occupied to determine the vertical extent of contamination, or a new core will be collected in an SMA where none previously existed. Proposed core locations and depths were selected to target spatial gaps from the RI subsurface data. Rationale for placement of PDI cores were based on the following concepts relative to the subsurface:

- **Spatial Resolution**. For portions of SMAs with limited subsurface data, cores were located to achieve an approximately 250 to 300 ft spacing distance to the next nearest historical coring location within an SMA, to refine the spatial resolution between data and provide improved understanding of subsurface concentration gradients between samples.
- **Horizontally Unbounded.** For spatial boundaries of SMAs with limited historical core coverage near the boundaries of a cleanup footprint, especially in dredge areas, cores were located to refine the horizontal extent of subsurface data in dredge footprints where SMAs are horizontally unbounded. This particularly applies to subsurface volume estimates toward the navigation channel.
- **Vertically Unbounded**. For portions of SMAs with historical cores, where the extent of subsurface contamination is vertically unbounded (did not “tag bottom” with a confirmed chemical concentration at depth below RALs), new PDI cores were located in the general vicinity of these RI stations (re-occupied station) to identify the vertical extent of contamination. As stated in the ROD, contamination in the subsurface sediment was identified as deep as 17 ft below mudline (bml) in the navigation channel and 19 ft bml in other areas (EPA 2017a).
- **No Subsurface Data**. For SMAs, especially those designated in the ROD for dredging, where no subsurface data previously existed, cores were located to define subsurface concentrations with depth in these areas. However, these small areas may be contouring artifacts within the geographic information system (GIS) program and may not represent actual areas of subsurface contamination. These areas will be reviewed in more detail and discussed with EPA prior to starting field work, to determine if a core is necessary in these isolated areas.
- **Nearshore Data Coverage.** For portions of SMAs with limited near-shoreline shallow cores, or no cores, PDI cores were placed in nearshore areas to provide spatial coverage towards shore for large dredging footprints, where no subsurface data exists. In the shallow region, the maximum depth of contamination was estimated to be 3.5 ft bml (EPA 2017a). Six ft depths are targeted for these nearshore (shallow) areas.

- Cores were not located in areas where remedial caps have already been placed or in the RM 11E early action area where additional subsurface data have already been collected in the last few years and remedial design negotiations are currently underway between EPA and the RM 11E Group. Figure 2e includes the approximate footprint of the RM 11E early action area.

With respect to elevations and depths bml, the ROD describes three Site regions: 1) the navigation channel and FMD areas; 2) the intermediate region (outside the navigation channel and FMD areas to -2 ft CRD [about +3 ft NAVD88]); and 3) the shallow region (shoreward of -2 ft CRD). The ROD indicates sediment with concentrations above the RALs will be dredged to at least 5 ft bml, where practicable. For the navigation channel/FMD and intermediate region, deep cores will be advanced 10 to 20 ft bml depending on the estimated vertical extent of contamination in a SMA; these cores are referred to as deep cores because they are generally located in deeper water compared to the nearshore cores. For the shallow region, cores located in the nearshore area will be advanced to a depth of 6 ft bml; these cores are referred to as nearshore cores. Deep core intervals (0 to 20 ft bml) may be collected and archived at 1 ft sample intervals from the area expected to be the bottom of contamination. The bottom 2 ft section of retained sediment from each core will also be archived regardless of the target depth. Archiving will be completed in accordance with RI Round 2 FSP (Integral 2004).

A fourth region, the riverbank region (defined as the "top of bank down to the river" in the ROD) is not included in this PDI study. The riverbank region will be addressed on a site-specific basis by EPA as part of PHSS remedial activities or Oregon Department of Environmental Quality under source control. This PDI study is focused in areas below the shoreline defined generally as the mean high water (MHW) (8 ft CRD, which is equal to about +13 ft NAVD88).

2.2.1 Example Cross Sections

Cross sections of four large SMAs were developed to help illustrate core location selection rationale (Figures 4a through 4d). Cross sections were drawn for SMAs with six or more PDI cores and large Alt F Mod active remedial footprints. Each cross section shows a mudline elevation bathymetry contour, historical RI surface sediment grabs and subsurface core locations, total PCB and total PAH concentration data (horizontally and vertically), and proposed PDI core locations. Areas with steeper slopes show two mudline bathymetry contour lines: a nearshore line and a toe of slope line. Figures 4a through 4d show bathymetry contours that follow a set elevation datum (i.e., CRD 2009) in the upper panel; the cross sections, with an associated mudline, are used to project artifacts on a set plane in space in the lower panel. The cross-section figures are summarized below, and a core-by-core rationale is provided in Table 1.

- In Figure 4a (section A-A' RM 1.9 to RM 2.7), the cross section illustrates the limited subsurface data at the downstream end of the SMA (RM 2) and at the upstream end (RM 2.5); three cores are proposed in these areas. In the middle of the SMA (RM 2.3), PCB RAL exceedances extend to the bottom of the PDI cores (depth of contamination is vertically unbounded); four cores are proposed to fill this area. The last proposed core (RM 2) is located as a result of data greater than 300 ft apart and have varying depths of contamination between existing data.

- In Figure 4b (section B-B' International Slip), a total of seven cores are planned. Four PDI cores are located in areas with less dense historical sampling in the mouth and middle portions of the slip where contaminant thicknesses vary. Three additional PDI cores will confirm the vertical depth of contamination near the head of the slip, as a result of historical cores vertically unbounded. The step-wise mudline contours of previously dredged areas are also visible in Figure 3b.
- In Figure 4c (section C-C' RM 6.8 to RM 7.5), large remedial dredging areas are identified in the downstream shallow areas where cores are limited, and those that exist are vertically unbounded (depth of contamination is not confirmed). The upstream area has several RI cores that are vertically unbounded at depth for total PCBs. The proposed PDI cores in the downstream area will provide spatial coverage of the vertical extent of contamination. The two upstream PDI cores are intended to confirm the vertical depth of contamination; this SMA has PAH and D/F exceedances vertically unbounded.
- In Figure 4d (section D-D' Swan Island Lagoon), 10 PDI cores are proposed over the length of the lagoon for spatial coverage, and four of seven cores near the head of the lagoon are intended to confirm the vertical extent of PCB contamination exceeding RALs (some of the historical cores are vertically unbounded).

2.2.2 Sample Types, Locations, Depths

Subsurface sediment cores will be collected across the Site between RM 1.9 and RM 11.8 based on the rationale described in Section 2.2.1. Proposed locations are presented in Figures 2a through 2e. Subsurface sediment samples from shallow (nearshore) cores will vary in target collection depth from 0 to 6 ft for (shallow nearshore region) and from 0 to 20 ft target depth for the deep cores (navigation channel/FMD and intermediate region). Most of the deep cores will be driven 15 ft bml or until refusal. Core locations may be modified based on the bathymetry, surface sediment sampling work, contouring artifacts, or other additional information with EPA approval. The communication strategy with EPA will follow Section 2 of the QAPP (AECOM and Geosyntec 2018a). Table 1 presents the location, core depths, location identification numbers (IDs), and rationale for subsurface sediment location selection based on the criteria described above.

Subsurface core samples will be visually logged and processed at 2 ft continuous intervals (based on the recovered depth) along the entire length of the accepted core, unless core stratigraphy indicates otherwise (see discussion in Section 4.4). The minimum sample interval will be 1 ft thickness of actual core material. The first sample will be collected from the 0 to 2 ft interval, regardless of stratigraphy. One ft sample intervals may be collected and archived from the area expected to be the bottom of contamination, to potentially provide a refined depth of contamination. The very bottom 2 ft interval of retained sediment from the core, will also be processed and archived, pending results of the upper intervals (especially for the nearshore cores).

Subsurface sample counts and selected analytes are presented in Table 2. The 60 deep cores will be collocated with PDI surface sediment grab locations collected from the 0 to 30 centimeter (0 to 1 ft) interval. Proposed subsurface core station IDs, mudline elevations, and coordinates are presented in Table 3. Figure 2 presents the proposed core locations within the Site. Core location and sample IDs will correspond with the surface sediment station ID; therefore, the core station IDs will not be numerically sequential.

2.2.3 Sample Nomenclature

The sample identification scheme for subsurface sediment sample collection will utilize a three-letter project identification code followed by a two-letter sample matrix code, unique station code, and sample depth interval. See Section 4.2 and Table 4 in the project QAPP (AECOM and Geosyntec 2018a) for details. In summary, the identification scheme follows:

- Project phase (PDI).
- Sample matrix (SC [sediment core]).
- Unique, sequential station number (S001 to S263). Station numbers are based on placement within the location of the river (from downstream to upstream). Surface sediment grabs (non-random) and cores are all grouped together for numbering purposes.
- Sample interval depth (2 ft up to 20 ft).

For example, a subsurface sediment core at station 10 collected from a recovered depth interval of 6 to 8 ft would have the sample ID PDI-SC-S010-6to8. See Section 4.2.1.2 of the QAPP for nomenclature associated with field duplicates and other QA/QC samples. Additional data fields that describe each unique sample and core location will be recorded in the field forms and will be included in the project database, as described in the project Data Quality Management Plan (DQMP) (AECOM and Geosyntec 2018b). These may include, for example, core recovery, *in situ* sample depth, recovered sample depth, mudline elevation, RM, SMA ID, and collection method.

2.3 Sampling Schedule

Subsurface sediment coring is targeted for the second and third quarters of 2018 (beginning July), after the surface sediment sampling and bathymetry survey have been completed, and before fish tissue sampling begins in July/August 2018. Subsurface sediment coring is expected to last 3 weeks using two sampling vessels (one vessel for deep coring and another vessel for the nearshore coring). After 2 weeks into the coring program, field progress will be assessed, and if it appears that the sampling effort is behind schedule, a third vessel and crew will likely be mobilized to complete the coring in the targeted sampling period.

2.4 Key Changes from Previously Approved RI FSPs

Subsurface sediment coring will be performed in accordance with RI project plans (Integral 2002, 2004, and 2006), except as noted in the bullets below and Section 4. SOPs from the RI will be made readily available as hard copies and PDFs on SharePoint for field staff to reference before and during field work. Key PDI changes from the RI Round 2 FSP – Sediment Sampling and Benthic Toxicity Testing (Integral 2004) include the following:

- Subsurface sediment samples will only be analyzed for the focused COCs (PCB Aroclors, PAHs, D/F, DDx), grain size, total solids, and total organic carbon (TOC). If a sample is determined to contain greater than 50% fines, then it may be submitted for additional geotechnical properties using Atterberg Limits test (American Society for Testing and Materials [ASTM] D4318). The PDI study will target about 10 to 20 samples for testing with spatial coverage of the Site (one or two per river mile or per segment) and vertical coverage in the subsurface (2 to 4 ft depth, and 4 to 6 ft depth).
- The SOP from the RI described several different coring methods; the PDI study is intending to use a vibracore, but may consider other equipment (piston core, high frequency impact core or other device) for difficult areas that previously hit refusal (e.g., gravel) or areas with potential non-aqueous phase liquid (NAPL) (near RM 6 and RM 7 west) to help better refine the extent of NAPL.
- In areas with potential NAPL, a jar sheen test and Field Description Key will be used during core processing (see Appendix A for Field Description Key and Appendix B-1 for Jar Sheen test). When coring in areas with potential NAPL, sorbent booms and pads may be proactively deployed around the coring area and the coring equipment/vessels to minimize dispersion of NAPL sheens that may appear on the water surface.

Cores will be processed for analytical testing at 2 ft intervals, unless stratigraphy indicates otherwise, consistent with the RI and described in the 2004 Round 2 RI sediment FSP (see RI Sections 2.2.2 and 4.6.3 and Appendix E); relevant portions of these plans have been excerpted from the RI and included in Appendix B-2 of this FSP. Stratigraphy changes may include a major observational change in the two dominant grain sizes, depositional regime, or presence/absence of anthropogenic material/indicators such as sheen, NAPL, or debris.

3. PROJECT ORGANIZATION/FIELD TEAM

3.1 Team Organization and Responsibilities

Team organization is detailed in the PDI Work Plan and in Section 2 of the QAPP (AECOM and Geosyntec 2018a). As it relates to this FSP, AECOM and Geosyntec are coordinating activities including management of all subcontractors, field sampling, analysis, and reporting scoping tasks. The PDI Project Coordinator, Mr. Ken Tyrrell, and PDI Project Manager, Dr. Jennifer Pretare, Ph.D. (AECOM), will be responsible for overall project coordination and providing oversight on all project deliverables. Ms. Anne Fitzpatrick (Geosyntec) is the senior technical lead for this task. Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec) will be the Field Coordinators (FCs) and will be generally responsible for general field QA/QC oversight. The project chemists, Ms. Julia Klens-Caprio (Geosyntec), Ms. Amy Dahl (AECOM), and Ms. Karen Mixon (AECOM), will be responsible for coordination with laboratories regarding sample volumes, logistics, schedule, detection limits and matrix interferences, and ensuring overall data quality.

Gravity Marine Services (Gravity), of Fall City, Washington, will perform vessel support, with Mr. Shawn Hinz acting as a point of contact. Analytical laboratories include ALS Environmental (ALS) in Kelso, Washington, and TestAmerica Laboratories (TestAmerica) in Fife, Washington, Sacramento, California, and Knoxville, Tennessee. Additional coring contractors and equipment may be mobilized if needed, to improve core recoveries in difficult areas (e.g., refusal, large wood debris, gravel, cobbles, etc.).

3.2 Communication/Information Flow

The communication strategy is outlined in Section 2 of the QAPP (AECOM and Geosyntec 2018a). The FCs, Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec), will be the points of contact for field staff during the implementation of this FSP. Ms. Anne Fitzpatrick (Geosyntec) will be the senior technical lead consulting with the field staff on core placement and interpretations, as needed, for this task. Deviations from this FSP or the project-specific QAPP will be reported to the PDI Project Manager for consultation. Significant deviations from the FSP/QAPP will be further reported to representatives of the Pre-RD AOC Group and EPA by the PDI Project Coordinator.

3.3 Coordination with EPA

The PDI Project Coordinator will notify the EPA Project Manager 1 to 2 weeks prior to beginning any field activities so that EPA can schedule any oversight activities required. The PDI Project Coordinator will also notify the EPA Project Manager once field activities have been completed.

Split samples for chemical analyses can be provided to EPA upon its request. EPA's Project Manager should contact the PDI Project Coordinator to coordinate this activity and determine appropriate logistics. If EPA elects to collect split samples, collection at stations where field duplicates are taken is recommended so that EPA's comparison samples can be evaluated relative to the field and analytical variability measured by the project team.

4. SAMPLE COLLECTION PROCEDURES

The following sections describe the procedures and methods that will be used during subsurface sediment sampling in accordance with the project QAPP, and previously approved FSPs and

SOPs from the RI for methods. These procedures include health and safety procedures, sampling methods; recordkeeping; sample handling, storage, and shipping; and field quality control. All field sampling activities will follow procedures outlined in the project Health and Safety Plan (AECOM and Geosyntec 2018c).

4.1 Sampling Vessels and Equipment

Gravity will provide vessels and a Vibratory Core Tube Driver (vibracore) system to conduct subsurface sediment coring. Vibracore tubes will be advanced to various lengths as discussed in Section 2.2.2. Vibracore tubes will be sectioned on the vessel platform into transportable sizes (approximately 4 ft) and transported by vehicle to the AECOM Sample Processing Facility for processing. Core tubes will be kept upright to the extent practicable until processing.

Gravity will perform the coring activities utilizing two sampling vessels, R/V *Cayuse* and R/V *Tieton*, each vessel equipped with a model RIC-5500 vibracore system manufactured by Gravity. The RIC-5500 corer unit uses an electric motor to produce an adjustable 3,500 to 6,500 feet per pounds (ft/lbs) of impact force at a frequency of 1,500 vibrations per minute. The system is contained in a seafloor frame with legs. The RIC system will accept core tubes up to 10 meters in length and includes an active suction check valve adapter that mounts to the vibratory head for easy swap-out on deck. A power cable will be used to deploy the system, which includes surface power on the deck of the vessel and data/controls.

Both vessels contain a virtual anchoring system that incorporates autopilot and two small motors to keep the vessel on station without needing to set fixed anchors. The R/V *Cayuse* is a 26 ft research vessel with landing craft design, crew cabin, wash-down hose, and working area. The R/V *Tieton* is a 34 ft research vessel with landing craft design and crew cabin, pilot house, and working area. Both vessels have an A-frame with custom research winch and dynamic positioning system. A minimum of 4-inch-diameter Lexan (preferred) or aluminum core tubes and custom core catchers will be used for core collection. Lexan core liners are sturdier and do not bend as easily compared to plastic sample liners; therefore, Lexan sample liners will be used in areas where compacted sediments and/or cobbles/debris are expected. A mechanical piston corer may be used when continued refusal or inadequate recovery is experienced. Core tubes can be adapted with an internal, mechanical piston-type device to improve core recoveries, if needed. Both of these vessels and their coring equipment have been previously used on the lower Willamette River.

Alternative vessels are available and can provide additional or backup support for in-water sampling as needed. All vessels will be moored within Swan Island Lagoon and mobilized from Swan Island public boat launch.

Additional equipment needed for coring and sample processing equipment are identified on the equipment checklist in Appendix A-1. Sample containers and preservatives, as well as coolers and packing material, will be supplied by the analytical laboratory.

4.2 Station Positioning and Vertical Control

Station positioning and vertical control will be performed as outlined in detail in the attached SOP (Appendix B-3). A differential global positioning system (DGPS) unit will be used on the vibracore A-frame to confirm the horizontal sampling locations to an accuracy of 1 to 2 meters, consistent with the RI. The DGPS accuracy will be confirmed each morning at the PH-1 benchmark installed at the Swan Island boat launch for the project (see GPS station log in Appendix B-3). Confirmed station locations will be recorded to the nearest whole foot in North American Datum of 1983 National Adjustment of 2011 (NAD83 [2011]), State Plane Coordinate System (SPCS) Oregon North Zone, International Feet.

Vertical control will be established using an on-board fathometer or lead line to measure depth to mudline at core locations at the time of collection. The fathometer accuracy will be checked regularly by vessel contractor (Gravity) and calibrated when necessary following ASTM D6318 Standard Practice for Calibrating a Fathometer Using a Bar Check Method or other similar practice. Water depths will be converted to mudline elevations in ft NAVD88 based on synchronizing timestamped gauge data downloaded from the Northwest River Forecast Center for gauge PRT03, located near RM 12.8. As described in Appendix B-3, this river stage gauge data are reported in the Columbia River Datum (CRD), so a correction will be needed to convert to NAVD88. The vertical CRD will also be recorded. Water levels will be recorded to the nearest one tenth of a foot in the datum specified in the DQMP (AECOM and Geosyntec 2018b). Further details regarding station positioning and vertical controls are provided in Section 5.2 of Integral (2002).

4.3 Core Collection and Processing

Subsurface core sample collection will be performed as described in the RI Round 2 FSP, Section 4.0 (Integral 2004). In general, coring will follow these steps:

1. Subsurface sediment core collection:
    a. Core tube caps will be removed immediately prior to placement into coring device, in order to minimize potential core contamination.
    b. Position will be recorded when the vibracore first rests on the sediment surface.
    c. The vibracore will be advanced without power (under its own weight), then vibration will be applied until the core tube is advanced to the target depth or refusal.
    d. After a brief pause, the core tube will be extracted from the sediment using only the minimum vibratory power needed for extraction.
    e. As soon as the core tube daylights to the surface water/air interface, a bottom cap will be placed over the tube to prevent material loss out of the core catcher.

f. Inspect the exterior side-walls of core tube for signs of potential NAPL and scrapes/scoring of the aluminum walls from contact with dense gravel. If NAPL is suspected, then take appropriate field precautions as described in the RI FSPs and Appendix B-1.

g. The following core collection data will be recorded on the vessel (in the core collection log [Appendix A-2]):

    i. Date/Time. Local date and time when the vibracoring began at each station.

    ii. Depth to Mudline. Water depth at the sampling station at the time of core collection.

    iii. Total Drive Length. Core tube length and depth of the core tube penetration into the subsurface.

    iv. Recovered Length. Thickness of the sediment column retained in the core tube prior to sectioning and removal of the core catcher.

    v. Sediment Observation. Average grain size, color, notable odors, debris, etc. observed at each of the cut ends of the core section. Visual description will follow ASTM visual-soil classification procedure.

h. Core will be accepted, rejected, or stored on the vessel pending another drive attempt. If a core sample does not meet the core acceptance criteria, then field protocols will be followed as described in Section 4.4 of this FSP.

i. After core acceptance, water will be carefully decanted from the top of the core tube to minimize sediment disturbance. Cores will be cut into segments approximately 4 ft long for handling, storage, and transport. Core tubes will be capped with aluminum foil and plastic caps, scribed on the sidewalls with core and segment ID (A, B, C, etc.) and “up” arrow, stored upright with ice, then transferred upright from the sampling vessel to the AECOM Sample Processing Facility, and stored upright in refrigerators until processed.

2. Core Acceptance Criteria: each subsurface sediment core retrieved on deck will be compared to these acceptance criteria:

    a. Overlying water is present and the surface is intact.

    b. Core has at least 80% recovery versus penetration.

    c. Core tube is in good condition (not excessively bent).

    d. Core appears representative of surrounding area.

    e. Target penetration depth has been achieved or bedrock is encountered. If target depth is not reached due to cobbles, debris, refusal, or other difficult drilling conditions, an additional core will be attempted as described in the contingency plan (see Section 4.3.1). If NAPL is observed at depth in a core, then EPA will be notified.

4.3.1 Contingency Plan for Field Condition Impediments for Collecting Cores

During the subsurface sediment coring efforts, the field crew may encounter field conditions that preclude collection of acceptable cores at the planned location (e.g., limited access, poor recovery, safety concerns, debris/rock/bedrock causing refusal). No more than three attempts will be made to relocate the core within a 25 ft radius of the planned location.[2] If the first core attempt meets the acceptance criteria, then no additional cores will be collected at that station. If not, the cores from each attempt will be retained until an acceptable core (as defined above) is acquired; if an acceptable core cannot be obtained within a 25 ft radius, then the best of three attempts will be retained and processed. If recovery is poor for all three attempts (< 60% recovery) or the area within 25 ft is inaccessible, then core drives will be attempted from a larger radius (e.g., 50 ft radius) following discussions with the PDI Project Manager. If an acceptable core cannot be obtained from within a 50 ft radius, attempts may be made further from the target location in coordination with EPA.

If utilities run within 15 feet of a proposed coring location based on review of GIS maps and confirmed in the field with ”utility crossing” signage, then the coring location will be adjusted a minimum of 15 feet (using best professional judgement) and noted in the field notebook.

4.4 Core and Sample Processing

Subsurface sediment core processing at the field laboratory will follow these steps:

1. The AECOM Sample Processing Facility is at 1115 SE Caruthers Street, Portland, Oregon (phone #: 503-239-5884). The facility is approximately 20 blocks from the field site and will be used as a base for staging work, sample processing, sample/equipment storage, sample packaging and shipping, daily field team meetings, decontamination supplies, and other support needs (Figure 1).
2. The core tube will be split open to preserve the material stratigraphy inside the core tube using a table saw, hand-held circular saw, shearing tool, or similar device, according to methods described in RI Round 2 FSP (Integral 2004).
3. A photoionization detector (PID) will be used for pre-screening of each core. As soon as the core is split open, the PID monitor will be held in the ambient air space just above the open core and slowly moved down the core from top to bottom. PID readings will be recorded in the field notebook. If there is a “PID hit” or if sheens/petroleum-like odors are suspected, then a headspace screening will be conducted following procedures

[2] Distances proposed in this FSP were based on previous sediment project experience in EPA Region 10.

described in the RI Round 2 FSP (Integral 2004) Section 4.6.4, Field Screening; this section has been excerpted from the RI and included in Appendix B-4 of this FSP. PID calibration will follow manufacturer's instructions.

4. Sediment cores will be visually described following ASTM D-2488 Standard Practice for Identification of Soils (Visual-Manual Procedure, ASTM D-2488). A logging key of the visual classification method is provided in Appendix A-3.
5. If potential NAPL is observed, then a jar sheen test or other device will be used over the suspected NAPL interval to further estimate (qualitatively) the presence of NAPL; see SOP in Appendix B-1. Appendix B-1 also provides visual descriptors for residual or free-phase NAPL observations.
6. A hand-held field torvane will be used to measure shear strength and pocket penetrometer to measure compressive strength within each sample interval. Manufacturers instructions for each field parameter tool will be followed regarding use and calibration of field equipment.
7. Subsurface sample intervals will be 2 ft intervals unless lithology indicates otherwise. Minimum interval thickness will be 1 ft. Maximum thickness will be about 3 ft in general accordance with thickness criteria in RI Round 2 FSP (Integral 2004).[3]
8. Cores will be photographed and archived per the RI Round 2 FSP (Integral 2004).

   After the cores have been described and the sample intervals have been determined, sediment will be collected and homogenized within the determined sample interval until uniform in color and texture and placed into appropriate sample containers for laboratory analysis.
9. Core lithology, geotechnical indexes, PID readings, sample IDs, and sample depth intervals will be recorded in the core processing log (Appendix A-2).

SOPs from the RI will be followed. These SOPs are from Appendix F of the RI FSP for Round 2 (Integral 2004) and are consistent with Appendix D of the RI FSP for Round 3 (Integral 2006). Relevant SOPs have been excerpted from the RI and included in Appendix B-2 of this FSP. These SOPs include lists of supplies and equipment, equipment decontamination, core collection, subsurface sediment sample processing, chain-of-custody, and packaging and shipping samples. The SOPs will be available in hard copy and on the project SharePoint site for easy access by the field crews.

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[3] The RI Round 2 FSP discussed a range of 1 to 4 ft sample thickness. However, a goal of the PDI study is to refine contaminant depths, so in general, target thicknesses are much less than 4 ft (2 ft target).

4.5 Sample Handling and Transport

Chain-of-custody procedures will be followed as detailed in the RI Round 2 FSP (Integral 2004) Section 4.8. Samples will be stored on ice at 0 to 6 degrees Celsius (°C) in a field cooler and shipped to appropriate laboratories as detailed in the RI Round 2 FSP (Integral 2004). Sections 4.8.1 and 4.8.2 of the RI Round 2 FSP along with the SOPs in Appendix E of the RI FSP for Round 2 (Integral 2004) and Appendix D of the RI FSP for Round 3 (Integral 2006) provide additional details on custody, storage, and shipping details, respectively. Additional details are provided in Section 4.3 of the QAPP (AECOM and Geosyntec 2018a).

4.6 Field Logbook and Forms

All field activities will be recorded in a field logbook as outlined in detail in Section 4.3 of the RI Round 2 FSP (Integral 2004). Field forms (Appendix A-2 of this FSP) will be completed as outlined in detail in the RI Round 2 FSP (Integral 2004).

4.7 Decontamination Procedures

Decontamination procedures for all non-dedicated (reusable) sampling equipment (bowls, spoons, etc.) will follow methods detailed in the RI Round 2 FSP Appendix E Sediment Sampling SOP (Integral 2004). This SOP is consistent with the RI Round 3 FSP Appendix D Sediment Sampling SOP (Integral 2006). In summary, non-dedicated sampling equipment decontamination steps will include an initial rinse with vessel river water to dislodge particles, a scrub with brush and Alconox™ or other phosphate-free detergent, and then a rinse with deionized water. Additional rinses with nitric acid or methanol are not anticipated but may be considered based on sample conditions (e.g., excessive oily/tar residue). Rinses using nitric acid or methanol, if used, will be handled and disposed of according to RI Round 2 FSP Appendix F SOP. Sampling spoons and bowls will be covered with aluminum foil until use (dull side down). Gloves will be replaced before and after handling each sample to minimize sample contamination. Core tubes and core cutter heads will be washed in a similar manner.

4.8 Investigation-Derived Waste Disposal

Investigation-derived waste (IDW) disposal will occur as described in the Management of IDW SOP (Appendix B-5). In general, any excess water or sediment remaining after processing core collection and sectioning will be returned to the vicinity of the collection site. No excess sediment containing NAPL principal threat waste will be returned to the vicinity of the collection site; see IDW SOP in Appendix B-5 of this FSP. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station. Phosphate-free, detergent-bearing liquid wastes from decontamination of the core sampling equipment will be washed overboard or disposed into the sanitary sewer system. Waste solvent rinses, if needed, will be held in sealed plastic buckets and disposed of into the sanitary sewer.

Tyvek, gloves, paper towels, plastic sheeting, and other waste material generated during sampling will be placed in heavyweight garbage bags or other appropriate containers and placed in normal refuse containers for disposal at a solid waste landfill. Used core tubes will be washed and then recycled. Leftover sediment after core processing, and oily or other potentially contaminated IDW will be placed in appropriate containers, characterized for disposal, and disposed of at an appropriate EPA-approved waste facility.

4.9 Field Quality Control

Field QC samples are collected to assess variability within samples (e.g., duplicates), to evaluate if potential sources of sample contamination are present (e.g., rinsate and trip blanks), or to confirm proper storage conditions of samples (e.g., temperature blanks). All QA/QC procedures are detailed in the project QAPP. Requirements for field QC samples are provided in Table 4, and a summary of all field QC sample numbers is provided in Table 5. Field duplicates and other field QC samples, such as trip blanks, temperature blanks, and rinsate blanks, will be collected as outlined in Section 4.6.1 of the project QAPP. Rinsate blanks will be collected by pouring deionized water over the sampling spoons and core tubes after field decontamination. Rinsate blanks will be collected for each sampling vessel.

5. LABORATORY ANALYSIS

Subsurface sediment core samples will be sent to the following laboratories for physical and chemical analysis:

- ALS in Kelso, Washington, for PAHs and DDx
- TestAmerica in:
    - Fife, Washington, for PCB Aroclors, TOC, grain size, and total solids (and Atterberg Limits if selected)
    - Sacramento, California, for D/F
    - Burlington, Vermont, for Atterberg Limits

Field parameters (measured at the Sample Processing Facility) will include geotechnical index testing down the length of the core at about 2 ft intervals. Measurement tools will include a hand-held field torvane to measure shear strength and pocket penetrometer to measure strength.

Additional details on the analytical methods, QA/QC requirements and procedures, and laboratory specific QA/QC requirements are detailed in Section 4.6 of the project QAPP. All samples will be placed in laboratory-supplied sample containers and preserved according to analytical protocols. Sample containers, analytical methods, preservation requirements, holding times, and sample sizes are provided for all analyses in Table 6.

6. DATA MANAGEMENT AND REPORTING

6.1 Field Data Management

The procedures and activities outlined in this FSP are designed to ensure DQOs are met. As detailed in the project QAPP, the following data management procedures will be performed in the field:

- All samples will be given a unique identifier (Section 2.2 of this FSP).
- All samples will be collected and transported under chain-of-custody control (Section 4.5 of this FSP).
- Field logbooks and data sheets will be maintained (Section 4.6 of this FSP).
- Field QA/QC samples will be collected according to the project QAPP (Section 4.9 of this FSP).

6.2 Post-Analysis Data Management and Reporting

Analytical laboratories will be required to adhere to all QA/QC procedures outlined in the project QAPP. Laboratories will provide all data for field investigations in electronic format and QA/QC reports, including a narrative of the standard QA/QC protocols. Data validation and data management will be performed according to the project QAPP and DQMP. Following data validation, all data, supplementary information, and validator qualifiers will be compiled into an SQL Server database for the project. Data summary files will be provided to EPA as they become available after data validation and database management.

Results from the implementation of this FSP will be used to support the data use objectives described in Section 1.3 of the PDI Work Plan (Geosyntec 2017: Table 5). Data summaries and evaluations will be included in the PDI Evaluation Report.

7. REFERENCES

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TABLES

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	NAPL May Be Present	Additional Rationale
Deep Cores (N=60) (New Core Stations and Reoccupy Old Core Stations)											
RM 2E	1	4	PDI-SC-S004	X			Refine horizontal extent - north end	15	8	No	Better define horizontal gradient extent towards the north end (cores to the north do not tag bottom).
	2	7	PDI-SC-S007		X	C011-2	Refine vertical extent, unbounded to 16 ft bml	20-22	2	No	Reoccupy C011-2, which remains unbounded at depth with a concentration of 8,200 ug/kg PCB. Samples in proximity (C011-1, RB13, and C602) are all unbounded.
	3	9	PDI-SC-S009	X			Refine vertical and horizontal extent - southwest end	10	5	No	C604 is unbounded in vertical direction with a concentration of PCB between 75 and 200 ug/kg.
	4	10	PDI-SC-S010		X	C019-2	Refine vertical extent, unbounded to 16 ft bml	20-22	2	No	Reoccupy C019-2, which remains vertically unbounded with a concentration of 1,100 ug/kg PCB. Samples in proximity (C019-1, LWMC1, and C604) are all unbounded.
	5	11	PDI-SC-011	X			Refine horizontal and vertical extent	15	8	No	Better define horizontal gradient extent. No cores within 250 ft and nearby cores C020, C022, and C025-2 are vertically unbounded.
	6	15	PDI-SC-S015	X			Refine horizontal extent - southwest end	15	8	No	Better define horizontal towards the Navigation Channel. C605 did not tag bottom and had PCB concentration between 75 and 200 ug/kg.
RM 2.75E	7	19	PDI-SC-S019	X			Data at depth	15	8	No	No existing core in the dredge footprint. Nearby core C061, unbounded.
RM 3.5E	8	23	PDI-SC-S023		X	C0614	Vertical extent, unbounded to 10.9 ft bml	15-18	2	No	No existing core in the dredge footprint.
RM 3.8E (International Slip)	9	24	PDI-SC-S024	X			Refine horizontal extent	15	8	No	Improve concentration gradient. Spacing between cores +300ft.
	10	28	PDI-SC-S028	X			Refine horizontal extent	15	8	No	Improve concentration gradient between cores; vertical extent is different between them; spacing between cores +400 ft.
	11	30	PDI-SC-S030		X	LWMC3	Refine vertical extent in Alt F dredge footprint	15	2	No	LWMC3 unbound vertically with a concentation of PCB at 5,000 ug/kg for the entire core depth of 10 ft bml.
	12	31	PDI-SC-S031	X			Refine horizontal and vertical extent	15	8	No	Better refine horizontal and vertical extent of remediation area. Nearby grab SED11 had a PCB concentration of 2,000 ug/kg and nearby core C094 had a concentration of 2,100 ug/kg.
	13	32	PDI-SC-S032	X			Riverbank shallow core	15	8	No	Closest sample SED14 is vertically unbounded. Sample approximately 3 ft bml with a concentration of 1,100 ug/kg. Refine horizontal extent between cap and dredge.
RM3.9W	14	38	PDI-SC-S038	X			Refine horizontal and vertical extent	15	8	No	No historical cores in proposed dredge area.
RM 4W to 5W	15	53	PDI-SC-S053	X			Refine horizontal and vertical extent	15	8	No	Closest core is unbounded C626. Additionally, no historical cores in proposed dredge area.
RM 4.5E		-		No cores needed, ample amount of data and all shallow exceedances, Alt F dredge							
RM 4.51E	16	55	PDI-SC-S055		X	HC-S-42	Refine vertical extent	10	2	No	Reoccupy HC-S-42, which was vertically unbounded, core driven ~5 ft bml with a PAH concentration of 220,000 ug/kg. Help refine horizontal extent in nearshore area.
RM 4.52E		-		No cores needed, ample amount of data and all shallow exceedances, Alt F dredge							
RM 4W to 5W	17	62	PDI-SC-S062		X	C136	Refine vertical extent	15	2	No	Reoccupy C136, which is vertically unbounded, core driven ~15 ft bml with a PAH concentration of 80,000 ug/kg. No other core in existing dredge footprint.
	18	65	PDI-SC-S065		X	C142	Refine vertical extent	15	2	No	Reoccupy C142, which is vertically unbounded, core driven ~10 ft bml with a PAH concentration of 240,000 ug/kg. Hit refusal at 12.9'
	19	70	PDI-SC-S070		X	C179	Refine vertical extent	15	2	No	Reoccupy C179, which is vertically unbounded, core driven ~10 ft bml with a PAH concentration of 90,000 ug/kg. Next to C182, also unbounded vertically with a concentration of ~25,000 ug/kg.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	NAPL May Be Present	Additional Rationale
RM 5 to 6	20	83	PDI-SC-S083	X			Refine vertical/horizontal extent	15	8	No	Nearby historical core C221 Did not tag bottom and had a total PAH concentration >68,900 ug/kg.
	21	86	PDI-SC-S086	X				15	8	No	Nearby historical core PH15-13 did not tag bottom and had a total PAH concentration >85,700 ug/kg.
RM 5.5E	22	85	PDI-SC-S085	X			No existing cores in dredge footprint	15	8	No	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
	23	88	PDI-SC-S088	X				15	8	No	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
	24	92	PDI-SC-S092	X				15	8	No	No existing cores in dredge footprint, one core nearby vertically bounded at 10 ft bml; Alt F dredge/cap.
RM 6W	25	98	PDI-SC-S098	X			Define vertical extent	15	8	No	Horizontally define Navigation Channel. Need core to define vertical extent. CS003 was less than 1 foot bml, with a concentration of 34,800 ug/kg. Also refine Navigation Channel extent.
	26	103	PDI-SC-S103	X			Horizontal delineation along Navigation Channel, also refine vertical extent for proximal cores	15	8	No	Horizontally define Navigation Channel. No core currently within proposed dredge footprint.
	27	109	PDI-SC-S109	X				15	8	No	Refine concentration gradient towards Navigation Channel and at depth. Closest cores ~250 ft away DGS-08C (in Navigation Channel, PAH concentration of 1,800,000 ug/kg). Downriver of LWMC11, unbounded sample with a PAH concentration of 8,400,000 ug/kg and DGS-19SC with a PAH concentration of 4,500,000 ug/kg.
	28	108	PDI-SC-S108		X	C244	Define vertical extent	15	2	No	Reoccupy C244 which is vertically unbounded, core driven ~10 ft bml with a PCB concentration of 250 ug/kg. Southern edge of proposed dredge footprint.
	29	113	PDI-SC-S113		X	C258	Refine vertical extent	15-18	2	No	Reoccupy C258 which is vertically unbounded to ~10 ft bml with a PAH concentration of 290,000 ug/kg.
RM 6.8E	30	131	PDI-SC-S131	X			Refine vertical/horizontal extent in the low spot near C291	15	8	Yes	Distance between cores is greater than 300 ft. Two of the four closest cores are unbounded vertically with PCB concentrations of 250 ug/kg and 750 ug/kg.
RM 7E	31	144	PDI-SC-S144	x			Refine horizontal and vertical extent	15	8	No	Proposed dredge area with historical cores greater than 250 ft away.
RM 7W	32	136	PDI-SC-S136	X			Refine vertical extent	15	8	No	Proposed dredge area around C311, DGS-37SC, SD072, and C316 cores are all vertically unbounded and have PAH concentrations >50,000 ug/kg and up to 570,000 ug/kg.
	33	139	PDI-SC-S139	X			Refine vertical extent	15	8	Yes	Proposed dredge area around WB-66 is unbounded vertically and horizontally and has 2,3,7,8-TCDD concentrations up to 0.0015 ug/kg.
	34	146	PDI-SC-S146	X			Define vertical extent	15	8	Yes	Proposed dredge area around C679 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.003 ug/kg.
	35	150	PDI-SC-S150	X			Define vertical extent	15	8	Yes	Proposed dredge area around LWMC14 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.002 ug/kg. Surrounding unbounded samples are WB-37, WB-41, and SD092 with concentrations up to 0.007 ug/kg.
	36	151	PDI-SC-S151	X			Define vertical extent	15	8	Yes	Proposed dredge area south of WB-34. WB-34 is unbounded vertically and has a 2,3,7,8-TCDD concentration of 0.001ug/kg.
	37	155	PDI-SC-S155	X			Define extent	15	8	No	No historical cores within proposed dredge footprint.
RM 7W to 8W	38	157	PDI-SC-S157		X	C690	Refine vertical extent	20	2	No	Proposed dredge area with no historical cores.
	39	163	PDI-SC-S163	X			Inside pier has no cores	15	8	No	Inside proposed dredge area has no core samples.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	NAPL May Be Present	Additional Rationale
RM 8E to 9E (Swan Island Lagoon)	40	172	PDI-SC-S172	X			Refine vertical extent	15	8	No	Area between C372 and PSY18C (cores are over 400 ft apart) had PCB concentrations of ~200 ug/kg and >500 ug/kg, respectively. C372 is unbounded vertically.
	41	176	PDI-SC-S176	X			Refine vertical extent	15	8	No	Define vertical extent between C702 and C703. Additionally, provide additional coverage near pier area where there are limited historical cores.
	42	178	PDI-SC-S178	X			Refine vertical extent	15	8	No	Area between C364 and PSY20C (cores are over 600 ft apart) had max a PCB concentration of >250 ug/kg and 2,300 ug/kg, respectively.
	43	191	PDI-SC-S191	X			Refine vertical extent	15	8	No	Proposed dredge area SD133 was unbounded vertically and had a PCB concentration of 2,400 ug/kg.
	44	198	PDI-SC-S198	X			Refine vertical extent	15	8	No	Better refine vertical gradient between C379 and PSY11C (cores are over 600 ft apart) and had a max PCB concentration of >750 ug/kg and >7.5 ug/kg, respectively.
	45	203	PDI-SC-S203	X			Refine horizontal extent	15	8	No	Limited horizontal cores within proposed Swan Island Lagoon dredge footprint.
	46	213	PDI-SC-S213	X			Refine horizontal/vertical extent	15	8	No	Gradient near C397 (cores up and down river are over 250 ft apart). C397 is vertically unbounded and had a max PCB concentration of >500 ug/kg.
	47	229	PDI-SC-S229		X	C421	Refine vertical extent	15	2	No	Only one core within pier area and over 200 ft to nearest sample location.
	48	230	PDI-SC-S230	X			Refine vertical extent	15	8	No	C405 and SD141 (cores are over 300 ft apart) and both are vertically unbounded. The max PCB concentration between the two cores was >500 ug/kg.
	49	238	PDI-SC-S238	X			Refine horizontal and vertical extent	15	8	No	Cores are over 250 ft apart and vertically unbounded.
RM9.1E	50	228	PDI-SC-S228	X			Refine horizontal and vertical extent	15	8	No	No historical cores in proposed dredge footprint.
RM 8W to 8.5W	51	218	PDI-SC-S218	X			Collect bank sample near C431	15	8	No	Proposed dredge area north east of C431, edge of dredge area is over 300 ft from nearest C431 core.
	52	221	PDI-SC-S221		X	C450	Refne vertical extent, hit refusal	15	2	No	Proposed dredge area around C450 is unbounded vertically to 10 ft bml and has a PCB concentration of 2,200 ug/kg.
RM 8.75W	53	222	PDI-SC-S222	X			Refine vertical extent	15	8	No	Area west of C455; C455 has a max PCB concentration of 6,000 ug/kg.
	54	226	PDI-SC-S226	X			Refine vertical extent	15	8	No	Proposed dredge area around LWMC19 is unbounded vertically and has a PCB concentration of 2,200 ug/kg.
RM 9.8W	55	248	PDI-SC-S248	X			Define horizontal/vertical extent	15	8	No	No historical cores within proposed dredge footprint.
	56	254	PDI-SC-S254	X			Cores are vertically unbounded, but there is 10 ft of clean overburden	15	8	No	Proposed dredge area north east of C738 and C739; both cores are vertically and horizontally unbounded with max concentrations >500 ug/kg of PCB.
	57	255	PDI-SC-S255	X			Refine nearshore extent	15	8	No	Proposed dredge area west of LMWC24. LWMC24 is vertically unbounded with max concentration >750 ug/kg of PCB.
	58	256	PDI-SC-S256		X	LWMC24	Refine vertical extent, unbounded to 10 ft bml	15	2	No	LMWC24 is unbounded vertically with a max PCB concentration >750 ug/kg and southward is more than 400 ft from shoreline, no nearshore cores.
	59	257	PDI-SC-S257	X			Cores are vertically unbounded, but there is 10 ft of clean overburden	15	8	No	Gradient between C739 and LWMC24; both cores are vertically unbounded, with max concentrations > 500 ug/kg of PCB.
RM10.8E	60	263	PDI-SC-S263	X			Define horizontal/vertical extent	15	8	No	No historical cores within porposed dredge footprint.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	NAPL May Be Present	Additional Rationale
Nearshore Cores (N=30) (shallow cores)											
RM 2E	61	2	PDI-SC-S002	X			Better define vertical and horizontal extent in shallow bank areas	6	3	No	Better define horizontal gradient extent towards the north end. Limited historical core data.
	62	14	PDI-SC-S014	X				6	3	No	Within a proposed dredge area and no historical core within 250 ft.
RM 3.5E	63	22	PDI-SC-S022	X				6	3	No	No existing core in proposed dredge footprint.
RM 3.8E (International Slip)	64	33	PDI-SC-S033	X				6	3	No	High concentration of unbounded cores with PCB concentrations >26,000 ug/kg (C092).
	65	34	PDI-SC-S034	X				6	3	No	No historical coverage in proposed dredge footprint.
	66	36	PDI-SC-S036	X				6	3	No	Close to hstorical cores C096 and C099. PCB concentrations range from 1,600 ug/kg to <500 ug/kg.
RM 4E	67	42	PDI-SC-S042	X				6	3	No	No historical cores within 250 ft.
RM 4.1W	68	45	PDI-SC-S045	X				6	3	No	Historical core SD017 unbounded to 4 ft depth with a PAH concentration >68,900 ug/kg.
RM 4.52	69	61	PDI-SC-S061	X				6	3	No	Spatial coverage, near historical cores T4-VC29 and T4-B411-06, which have PCB concentrations of 1,300 ug/kg and >75ug/kg, respectively.
RM 4.9W	70	64	PDI-SC-S064	X				6	3	No	No historical cores in proposed dredge area.
	71	66	PDI-SC-S066	X				6	3	No	Spatial coverage. Historical core near proposed area SGP-14 had a PAH concentration of >34,800 ug/kg and historical near core C160 was vertically unbounded to 8 ft depth.
RM 5.6E	72	82	PDI-SC-S082	X				6	3	No	Near historical core C203, was vertically unbounded to 10 ft depth and had a PCB concentration of 2,800 ug/kg and located approximately 230 ft away. Historic core C199 was vertically bounded at 6 feet with a PCB concentration greater than 75 ug/kg to 6 ft and located approximately 200 ft away.
RM 5.7W	73	95	PDI-SC-S095	X				6	3	No	Near historical core C240 is vertically unbounded to 3 ft depth bml and had a PAH concentration >128,000 ug/kg. Over 200 ft from nearest core.
RM 6.2W	74	105	PDI-SC-S105	X				6	3	No	Near historical cores SDDC24SB and SDDC25SB, vertically unbounded to 4 ft depth bml with PAH concentrations of 710,000 and 250,000 ug/kg, respectively.
RM 6.2E	75	112	PDI-SC-S112	X				6	3	No	Proposed dredge area with no historical cores within footprint.
RM 6.5W	76	117	PDI-SC-S117	X				6	3	Yes	Spatial coverage. No historical cores within 250 ft in proposed dredge footprint. Nearby historical core C136 has a 2,3,7,8-TCDD concentration >0.0006 ug/kg.
RM 6.7E (Willamette Cove)	77	121	PDI-SC-S121	X				6	3	No	Proposed dredge with no historical cores within footprint.
RM 6.8W	78	127	PDI-SC-S127	X				6	3	No	Proposed dredge with no historical cores within footprint.
RM 6.8E (Willamette Cove)	79	129	PDI-SC-S129	X				6	3	No	Proposed dredge with no historical cores within footprint.
RM 7W	80	140	PDI-SC-S140	X				6	3	No	Proposed dredge area with no historical cores within 200 ft.
	81	154	PDI-SC-S154	X				6	3	No	Nearby historical cores contain 2,3,7,8-TCDD concentrations up to 0.004 ug/kg. No shallow bank cores within 500 ft.
RM 8E to 9E (Swan Island Lagoon)	82	185	PDI-SC-S185	X				6	3	No	Spatial coverage between historical cores C364 and PSY16C which have PCB concentrations of 200 and 750 ug/kg, respectively.
	83	188	PDI-SC-S188	X				6	3	No	Spatial coverage. Nearby historical cores C392 and PSY30C have PCB concentrations of >750 ug/kg and <50 ug/kg, respectively.
	84	192	PDI-SC-S192	X				6	3	No	Nearby historical core DMMU1 was vertically unbounded to 10 ft depth with PCB concentration >250 ug/kg.
	85	219	PDI-SC-S219	X				6	3	No	No historical cores within 250 ft.
RM 8.1W	86	189	PDI-SC-S189	X				6	3	No	Proposed dredge with no historical cores within dredge footprint. Nearby historical core C431 had a PCB concentration of 1,100 ug/kg.
RM 9W	87	232	PDI-SC-	X				6	3	No	No historical core in proposed dredge footprint.
	88	245	PDI-SC-S245	X				6	3	No	Spatial nearshore coverage. Nearby historical core C477 vertically unbounded to 7 ft bml with a PCB concentration >500 ug/kg.
RM 9.6E	89	251	PDI-SC-S251	X				6	3	No	Proposed dredge location with no historical cores.
RM 10.2	90	260	PDI-SC-S260	X				6	3	No	Proposed remediation footprint with no historical cores.

Table 1. Subsurface Sediment Core Rationale

Alternative F Mod Active Footprint Area	Sequential Core Count	Core Location #	Station ID	New Core Station	Re-Occupy Old Station	Old Station	Rationale	Proposed Core Depth (ft bml)	# of Samples	NAPL May Be Present	Additional Rationale

Total # Deep Cores / Samples	46	14		393	
Total # of Shallow Cores / Samples	30			90	
Total Core Tube Length (Linear Ft)			1,015		
Total # of Subsurface Samples				483	

Notes:

Deep cores are collocated with an SMA surface sediment grab. There are a total of 60 collocated grabs (44 New Core Locations, 16 Reoccupy Core Locations).

Proposed core stations from RM 11E have been removed. The PDI study will rely on recent data collected within the SMA footprint.

Sample names will include Station ID and depth of sampling interval.

NAPL prediction based on Figures 3.2-1 and 3.2-2 from FS dated July 8, 2015.

Acronyms:

ug/kg = microgram per kilogram; bml = below mudline; E = east; ft = feet, PAH = polycyclic aromatic hydrocarbon; PCB = polychlorinated biphenyl; PDI = pre-remedial design investigation; PRP = potentially responsible party; RM = river mile; SMA = sediment management area; W = west

Table 2. Summary of Subsurface Sediment Sample Types, Numbers, and Analytes

Subsurface Sediment Core Type / Purpose	No. of Stations	No. of Samples	Analyte List (focused COCs)				
			PCB Aroclors	PAHs	PCDD/F	DDx	Grain size and TOC
Deep Core Stations	60	393	X	X	X	X	X
Nearshore (Shallow) Cores	30	90	X	X	X	X	X
Archive 1 ft Interval near bottom of core	TBD	TBD	Archive pending 2 ft results				
Total Count	**90**	**483**					

Notes:

Deep Cores are a combination of New Core Stations and Reoccupy Core Stations which range in depth from 10 to 20 feet.

Sample Collection will occur every 2 feet of depth except for reoccupy core stations.

Reoccupy Core Stations will have two samples collected (one at the historical depth and one 2 feet lower).

All Shallow ~~Bank~~ Core Stations will be to a target depth of 6 feet.

Deep Core Stations may have a co-located surface sediment grab sample (0 to 30 cm target depth).

Focused COCs include: DDx, PCB Aroclors, PAHs, PCDD/Fs. Grain Size and TOC also analyzed.

Selected fine-grained samples (up to 10) will also be anayzed for Atterberg Limits.

Acronyms:

COC = contaminant of concern; DDx = sum of dichlorodiphenyltrichloroethane and its derivatives; PAHs = polycyclic aromatic hydrocarbon; PCBs = polychlorinated biphenyls; PCDD/Fs = polychlorinated dibenzo-p-dioxins and furans; TBD = to be determined; TOC = total organic carbon

Table 3. Station Identification Scheme, Mudline Elevations, and Location Coordinates

Station ID	Core Description	Mudline Elevation (CRD - Feet)[a]	Proposed Location Coordinates (NAD83 [2011]; Intl Feet)[b]		Sequential Station Count
			Easting	*Northing*	
PDI-SC-S002	Shallow Core	N/A	7617870	724983	1
PDI-SC-S004	Deep Core	-3.5	7617674	724708	2
PDI-SC-S007	Deep Core	N/A	7617494	724204	3
PDI-SC-S009	Deep Core	-36.1	7617132	723879	4
PDI-SC-S010	Deep Core	-23.9	7617252	723775	5
PDI-SC-S011	Deep Core	-8.5	7617185	723519	6
PDI-SC-S014	Shallow Core	N/A	7617131	723185	7
PDI-SC-S015	Deep Core	-33.0	7616871	722877	8
PDI-SC-S019	Deep Core	-26.8	7616724	721584	9
PDI-SC-S022	Shallow Core	N/A	7617439	718310	10
PDI-SC-S023	Deep Core	-48.7	7617275	717743	11
PDI-SC-S024	Deep Core	-38.7	7618163	717155	12
PDI-SC-S028	Deep Core	-24.5	7619022	717184	13
PDI-SC-S030	Deep Core	-13.6	7619376	717045	14
PDI-SC-S031	Deep Core	-22.4	7619579	717144	15
PDI-SC-S032	Deep Core	-9.2	7619801	717238	16
PDI-SC-S033	Shallow Core	-1.9	7619895	717023	17
PDI-SC-S034	Shallow Core	N/A	7620011	717204	18
PDI-SC-S036	Shallow Core	N/A	7618072	716752	19
PDI-SC-S038	Deep Core	N/A	7616637	715830	20
PDI-SC-S042	Shallow Core	N/A	7618436	715951	21
PDI-SC-S045	Shallow Core	N/A	7617224	714365	22
PDI-SC-S053	Deep Core	N/A	7617469	713721	23
PDI-SC-S055	Deep Core	-9.3	7619660	713673	24
PDI-SC-S061	Shallow Core	N/A	7620462	713053	25
PDI-SC-S062	Deep Core	-12.4	7618175	712584	26
PDI-SC-S064	Shallow Core	N/A	7618256	712076	27
PDI-SC-S065	Deep Core	N/A	7618588	711681	28
PDI-SC-S066	Shallow Core	N/A	7618929	711020	29
PDI-SC-S070	Deep Core	-9.7	7619684	710016	30
PDI-SC-S082	Shallow Core	N/A	7622325	708748	31
PDI-SC-S083	Deep Core	-50.6	7621575	708069	32
PDI-SC-S085	Deep Core	N/A	7622302	708578	33
PDI-SC-S086	Deep Core	-50.8	7621839	707824	34
PDI-SC-S088	Deep Core	-36.9	7622381	708290	35
PDI-SC-S092	Deep Core	N/A	7622708	708151	36
PDI-SC-S095	Shallow Core	-8.6	7622008	707161	37
PDI-SC-S098	Deep Core	-45.6	7622652	706762	38
PDI-SC-S103	Deep Core	-39.8	7623053	706373	39
PDI-SC-S105	Shallow Core	N/A	7623049	706035	40
PDI-SC-S108	Deep Core	-11.3	7623957	706997	41
PDI-SC-S109	Deep Core	-44.6	7623821	706069	42
PDI-SC-S112	Shallow Core	N/A	7624572	706744	43
PDI-SC-S113	Deep Core	-40.5	7624300	705634	44
PDI-SC-S117	Shallow Core	N/A	7624686	705196	45
PDI-SC-S121	Shallow Core	N/A	7625899	706030	46
PDI-SC-S127	Shallow Core	N/A	7625928	704408	47
PDI-SC-S129	Shallow Core	N/A	7626904	705849	48
PDI-SC-S131	Deep Core	-31.6	7626895	705603	49
PDI-SC-S136	Deep Core	N/A	7626539	703726	50
PDI-SC-S139	Deep Core	-7.4	7627058	703342	51

Table 3. Station Identification Scheme, Mudline Elevations, and Location Coordinates

Station ID	Core Description	Mudline Elevation (CRD - Feet)[a]	Proposed Location Coordinates (NAD83 [2011]; Intl Feet)[b]		Sequential Station Count
			Easting	*Northing*	
PDI-SC-S140	Shallow Core	N/A	7627140	702977	52
PDI-SC-S144	Deep Core	N/A	7628759	704114	53
PDI-SC-S146	Deep Core	-16.4	7627591	702896	54
PDI-SC-S150	Deep Core	-7.0	7627909	702475	55
PDI-SC-S151	Deep Core	-28.8	7628124	702359	56
PDI-SC-S154	Shallow Core	N/A	7628333	701890	57
PDI-SC-S155	Deep Core	N/A	7628616	701529	58
PDI-SC-S157	Deep Core	-37.9	7628992	700980	59
PDI-SC-S163	Deep Core	-25.8	7629268	700352	60
PDI-SC-S172	Deep Core	-13.1	7633011	701895	61
PDI-SC-S176	Deep Core	-43.3	7632595	701151	62
PDI-SC-S178	Deep Core	-34.4	7632913	701345	63
PDI-SC-S185	Shallow Core	N/A	7633644	701791	64
PDI-SC-S188	Shallow Core	N/A	7632478	700346	65
PDI-SC-S189	Shallow Core	N/A	7630828	698942	66
PDI-SC-S191	Deep Core	-47.5	7632893	700640	67
PDI-SC-S192	Shallow Core	N/A	7633168	700669	68
PDI-SC-S198	Deep Core	-33.3	7633962	701063	69
PDI-SC-S203	Deep Core	-34.6	7634188	700563	70
PDI-SC-S213	Deep Core	-31.8	7634983	700093	71
PDI-SC-S218	Deep Core	N/A	7633085	696851	72
PDI-SC-S219	Shallow Core	-24.3	7635270	699677	73
PDI-SC-S221	Deep Core	-28.8	7633359	696916	74
PDI-SC-S222	Deep Core	-13.4	7633418	696810	75
PDI-SC-S226	Deep Core	N/A	7633678	696609	76
PDI-SC-S228	Deep Core	-17.1	7635600	697287	77
PDI-SC-S229	Deep Core	N/A	7635857	699177	78
PDI-SC-S230	Deep Core	-23.0	7636127	699520	79
PDI-SC-S232	Shallow Core	N/A	7634221	696225	80
PDI-SC-S238	Deep Core	-14.1	7636448	698736	81
PDI-SC-S245	Shallow Core	N/A	7635255	695640	82
PDI-SC-S248	Deep Core	-20.4	7636288	695194	83
PDI-SC-S251	Shallow Core	N/A	7637607	696102	84
PDI-SC-S254	Deep Core	-23.4	7637333	694600	85
PDI-SC-S255	Deep Core	N/A	7637134	694051	86
PDI-SC-S256	Deep Core	N/A	7637282	694038	87
PDI-SC-S257	Deep Core	-16.8	7637494	694352	88
PDI-SC-S260	Shallow Core	N/A	7639609	692691	89
PDI-SC-S263	Deep Core	N/A	7642066	691479	90

General Notes:

1. Conversion From CRD to NAVD88: Elevation (CRD) +5.38≈ NAVD88 (Geoid12b)
2. N/A = not available

Notes:

a) Vertical Datum: CRD (Columbia River Datum; Feet); based on 2009 NOAA bathymetry

b) Horizontal Projection: NAD83 (2011), State Plane Coordinate System (SPCS) Oregon North Zone (Intl Feet)

Sample names will include Station ID and depth of sampling interval.

Table 4. Field Quality Control Sample Requirements

QA/QC Sample Type	Frequency
Temperature Blanks	1 per cooler
Field Duplicates	1 per 20 samples
Field Equipment Rinsate Blanks	5 percent or 1 per week

Acronyms:
QA/QC = quality assurance/quality control

Table 5. Summary of Estimated Number of Field Quality Control Samples

Subsurface Sediment Sample Type	No. of Samples	Estimated Number of Field Weeks	Field Duplicates	Field Equipment Rinsate Blanks
Deep Core Stations	393	19.7	20	20
Nearshore (Shallow) Core Stations	90	3.0	5	3
Total Count	**483**	**22.7**	**25**	**23**

Notes:
Estimated number of field weeks for one vessel; two vessels are planned to be in the field.
Field Duplicates will each be collected at a rate of 1 per 20 samples.
Rinsate Blanks will be collected at a rate of 1 per 20 samples or 1 per week or piece of equipment.

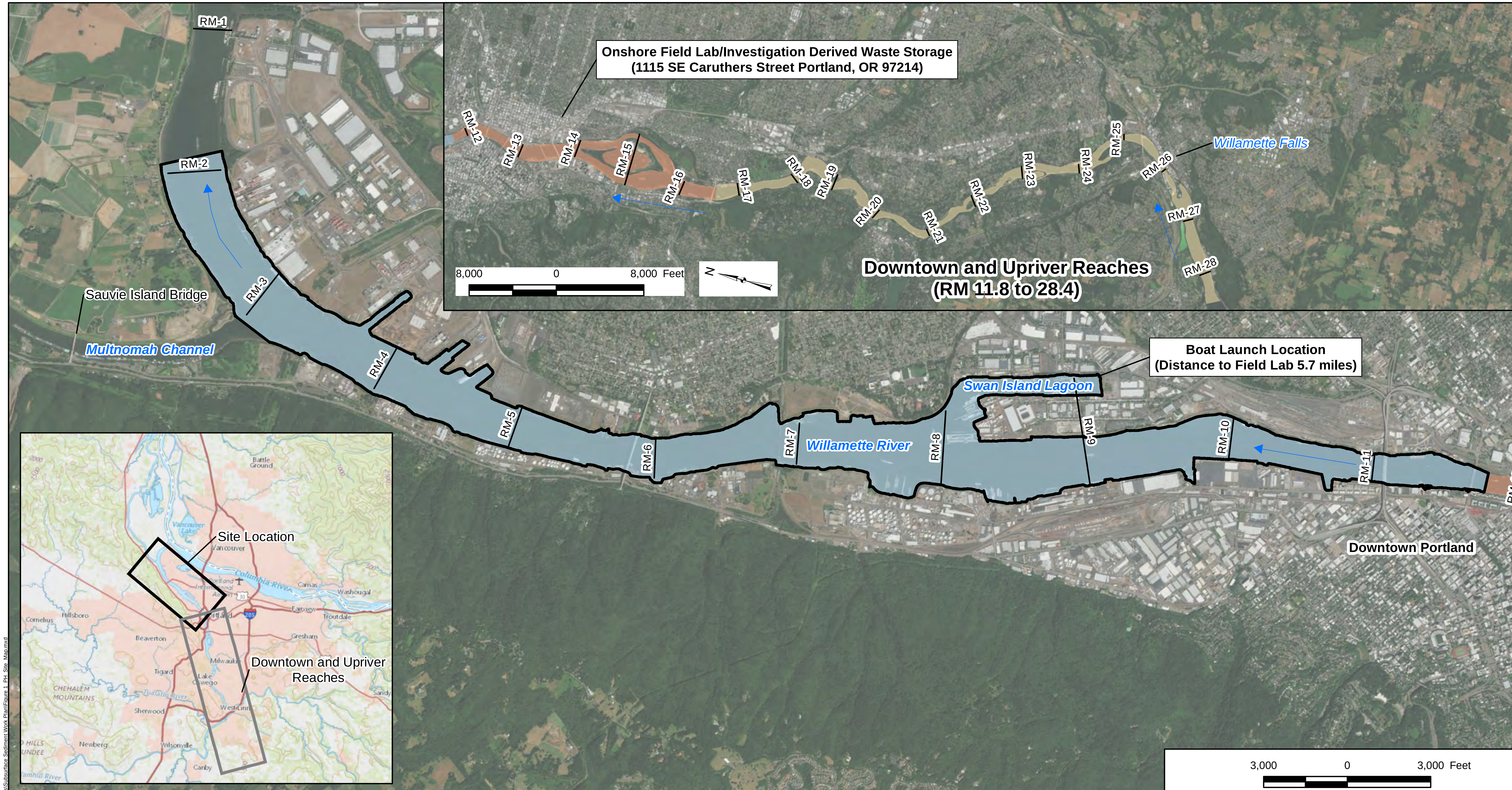
Table 6. Analysis Method, Sample Containers, Preservation, Holding Times, and Sample Volume

Sediment Parameter	Method	Container		Preservation	Holding Time	Minimum Sample Size (wet weight grams)
		Type	***Size***			
PCBs Aroclors	EPA 8082A	WMG	8 oz	Refrigerate, 0 to 6ºC Deep Frozen (-10ºC)	1 year, 1 year	100
PCDD/PCDFs	EPA 1613B	Amber Glass Jar	8 oz	Refrigerate, 0 to 6ºC Deep Frozen (-10ºC)	1 year, 1 year [a]	100
PAHs	EPA 8270SIM	Amber Glass Jar	8 oz	Refrigerate, 0 to 6ºC Deep Frozen (-10ºC)	14 days, 1 year	100
DDx	EPA 1699M			Refrigerate, 0 to 6ºC Deep Frozen (-10ºC)	1 year	100
Grain size	ASTM D7928 / D 6913	G or P	16 oz	NA	NA	100 to 150
Atterberg Limits	ASTM D4318	P	16 oz	NA	NA	500
Total organic carbon	EPA 9060	WMG	4 oz	Refrigerate, 0-6°C	28 days	25
Total solids	EPA 160.3	WMG				

General Notes:
Refrigerate preservation times consistent with PSEP protocols for Washington State.
Frozen preservation times provided from PSEP 1986.
Method detection limits presented in the project QAPP.
Selected fine-grained samples will be analyzed for Atterberg Limits.
Footnotes:
a) stored in darkness

Acronyms:
ºC = degrees Celsius; DDx - sum of dichlorodiphenyltrichloroethane and its derivatives; G = glass; oz = ounce; P = plastic; PAHs - polycyclic aromatic hydrocarbon; PCBs = polychlorinated biphenyls; PCDD/Fs = polychlorinated dibenzo-p-dioxins and furans; PSEP = Puget Sound Estuary Protocol; QAPP = Quality Assurance Project Plan; WMG = wide-mouth glass

FIGURES



Legend

- Flow Direction
- River Mile Marker
- Superfund Site Boundary (RM 1.9 to 11.8)

Study Area

- Site Area (RM 1.9 to 11.8)
- Downtown Reach (RM 11.8 to 16.6)
- Upriver Reach (RM 16.6 to 28.4)

N

Note:
1. Aerial Imagery provided by ESRI Basemaps 2016

Portland Harbor Site Map

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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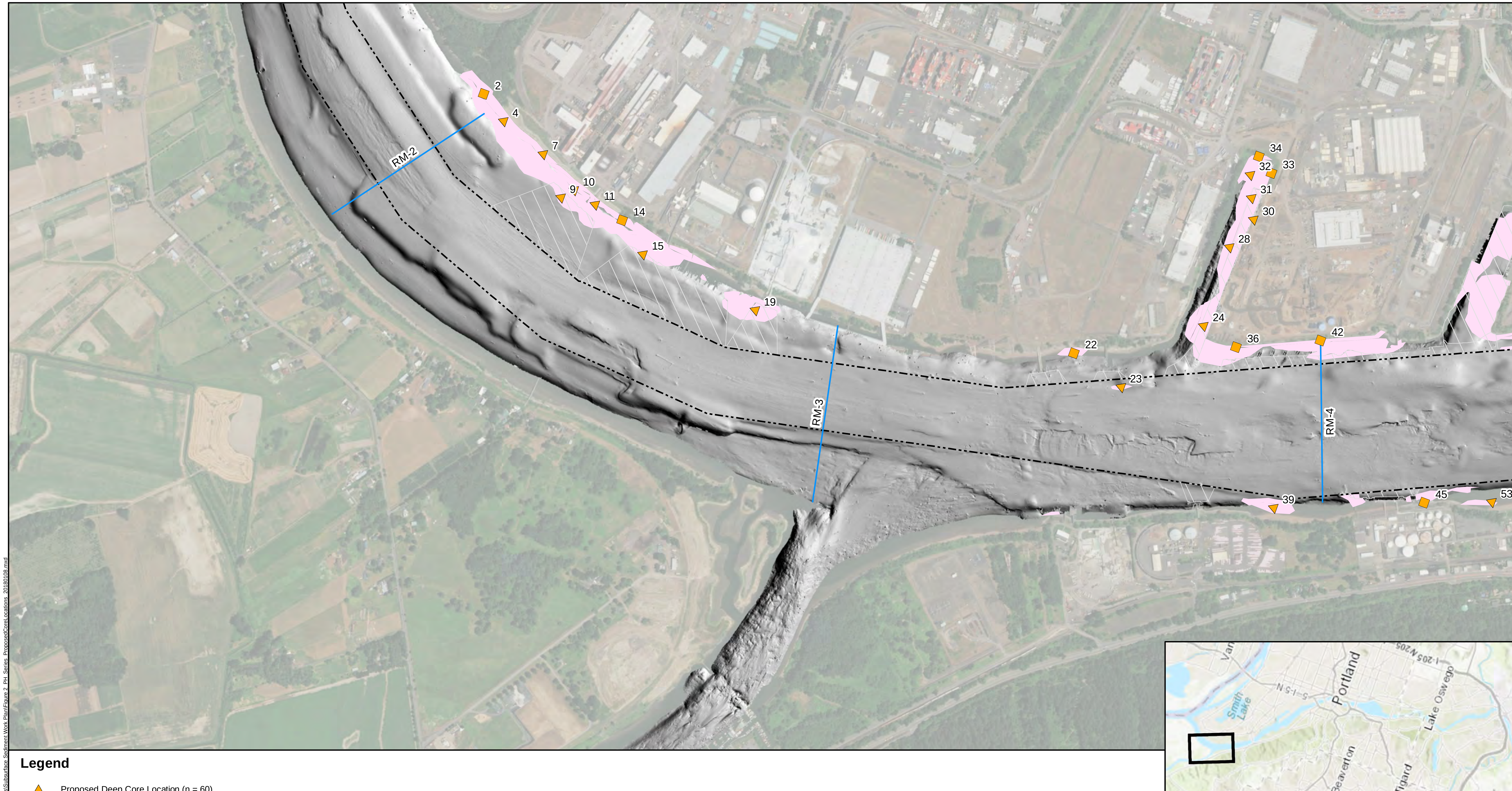
Figure 1

MI/SEA | March 23, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 1.9 to 4

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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Figure 2a

MI/SEA | January 18, 2018

Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

N

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 4 to 6

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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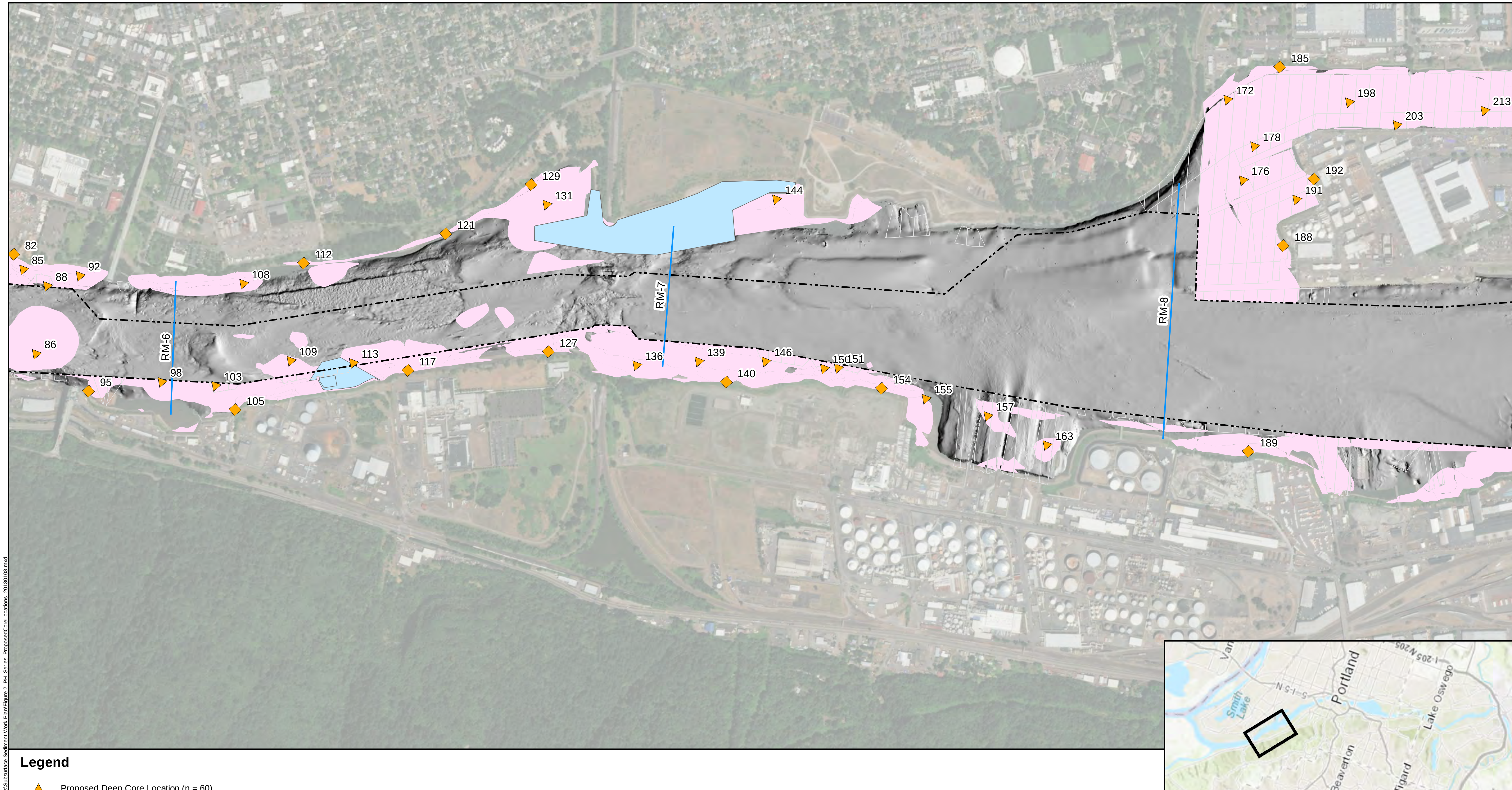
MI/SEA	March 23, 2018

Figure 2b



Legend

- ▲ Proposed Deep Core Location (n = 60)
- ■ Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream. Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

N

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 6 to 8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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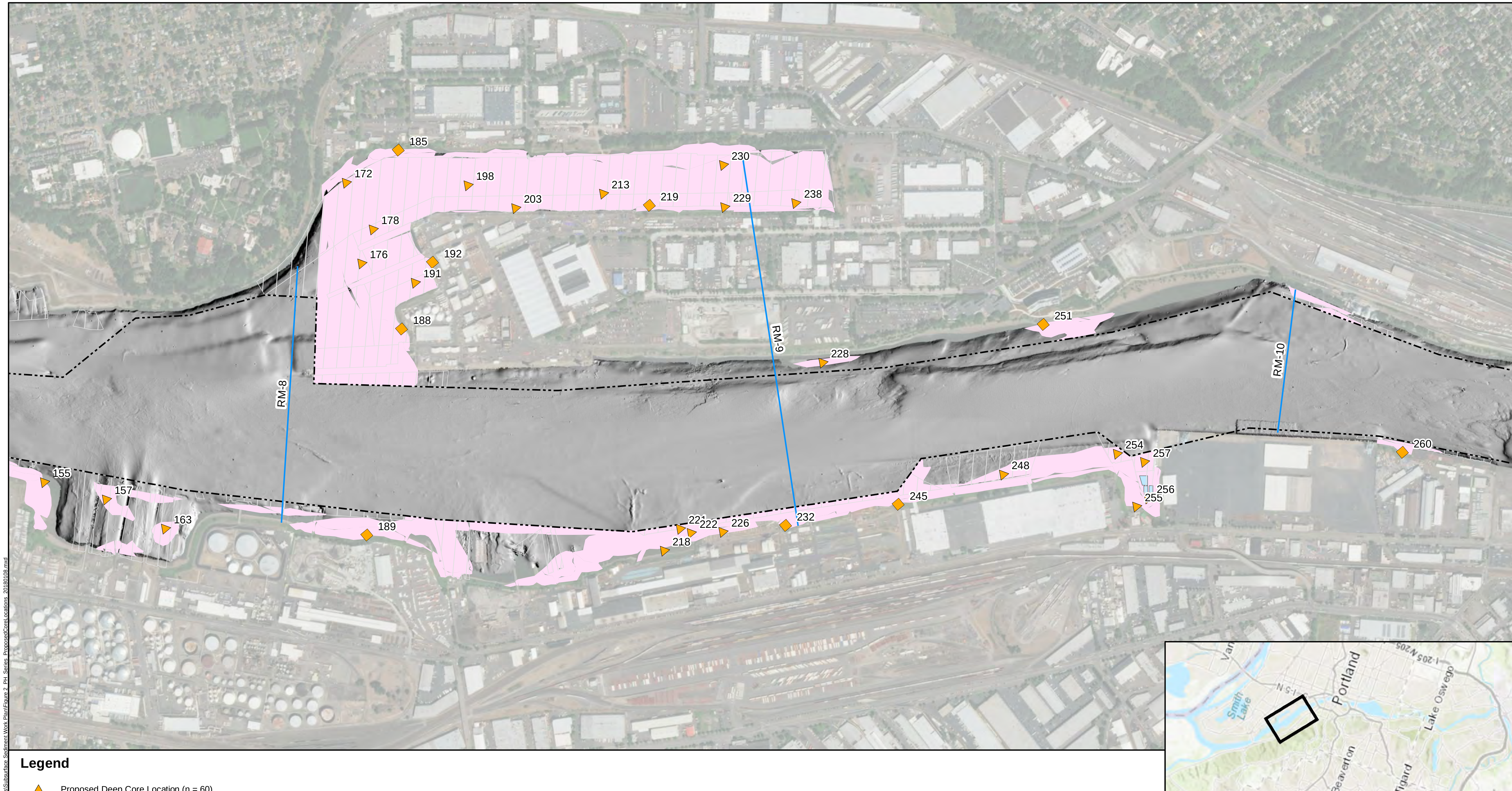
MI/SEA | January 18, 2018

Figure 2c

Path: P:\Projects\Portland Pre-Design PNG0767A\900 GIS and CAD\MXDs\Subsurface Sediment Work Plan\Figure 2 PH Series ProposedCoreLocations 20180108.mxd



Legend

- ▲ Proposed Deep Core Location (n = 60)
- ■ Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

1,000 500 0 1,000 2,000 Feet

Proposed Subsurface Sediment Sampling Locations RM 8 to 10

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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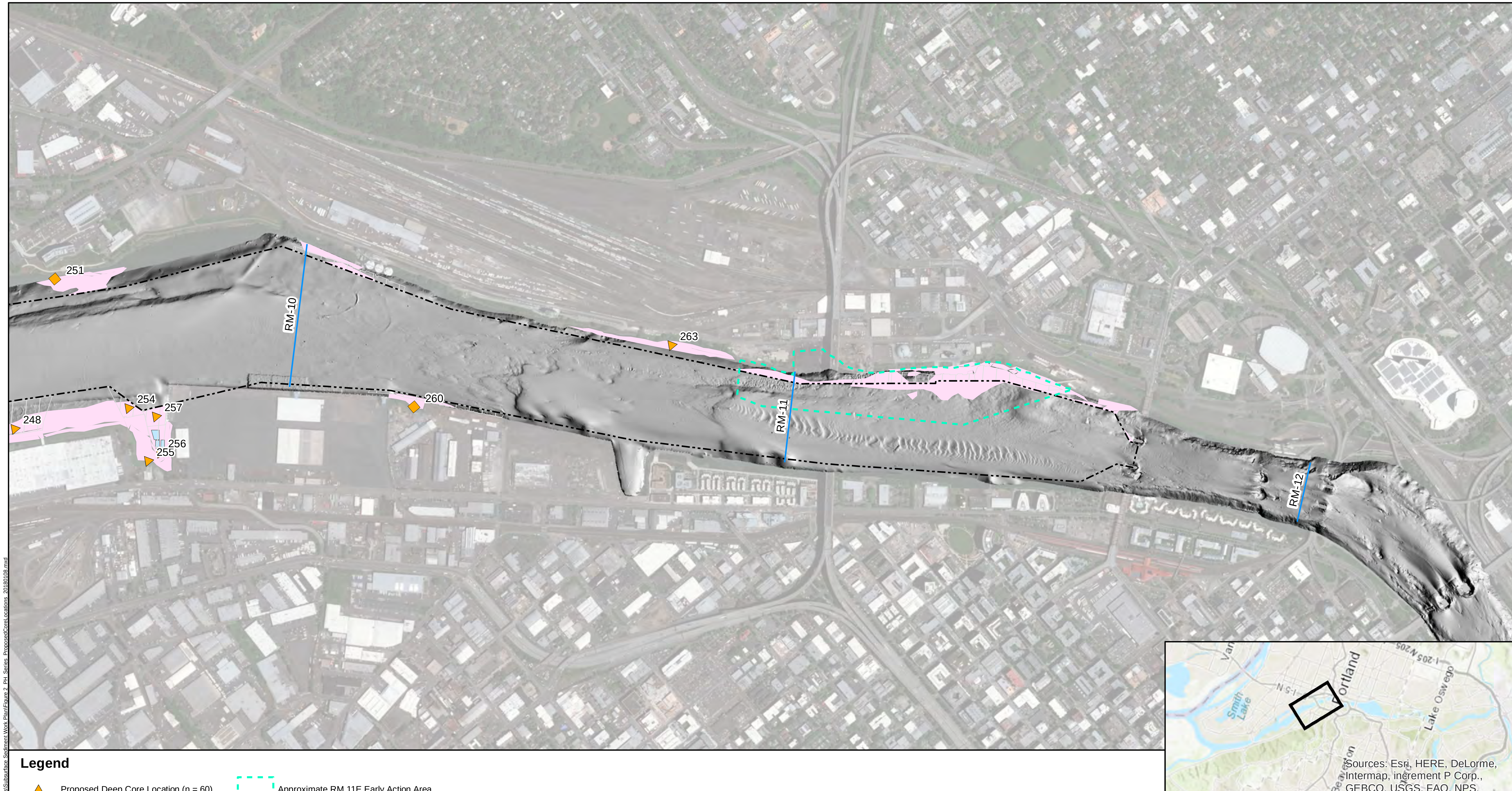
MI/SEA	January 18, 2018	Figure 2d



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- Alternative F Mod SMA Footprint
- Capped Area (Existing)
- Potential FMD\Berthing Area
- Superfund Site Boundary (RM 1.9-11.8)
- Navigation Channel
- Approximate RM 11E Early Action Area

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream. Only Subsurface Deep Cores and Shallow Cores shown.
3. n - sample count, RM - river mile, SMA - sediment management area.

1,000 500 0 1,000 2,000 Feet

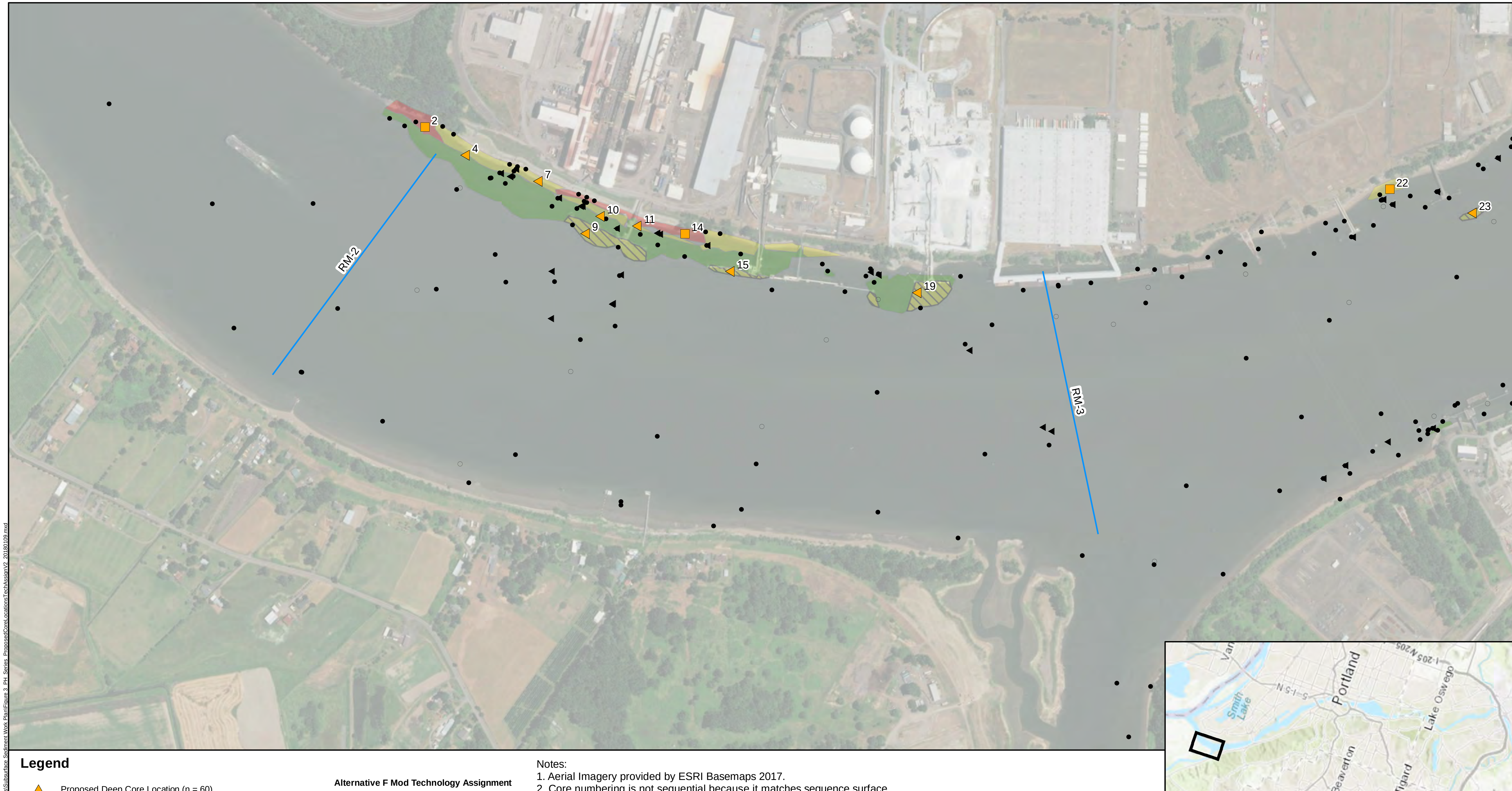
Proposed Subsurface Sediment Sampling Locations RM 10 to 11.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

AECOM Geosyntec consultants

Figure **2e**

MI/SEA | March 23, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

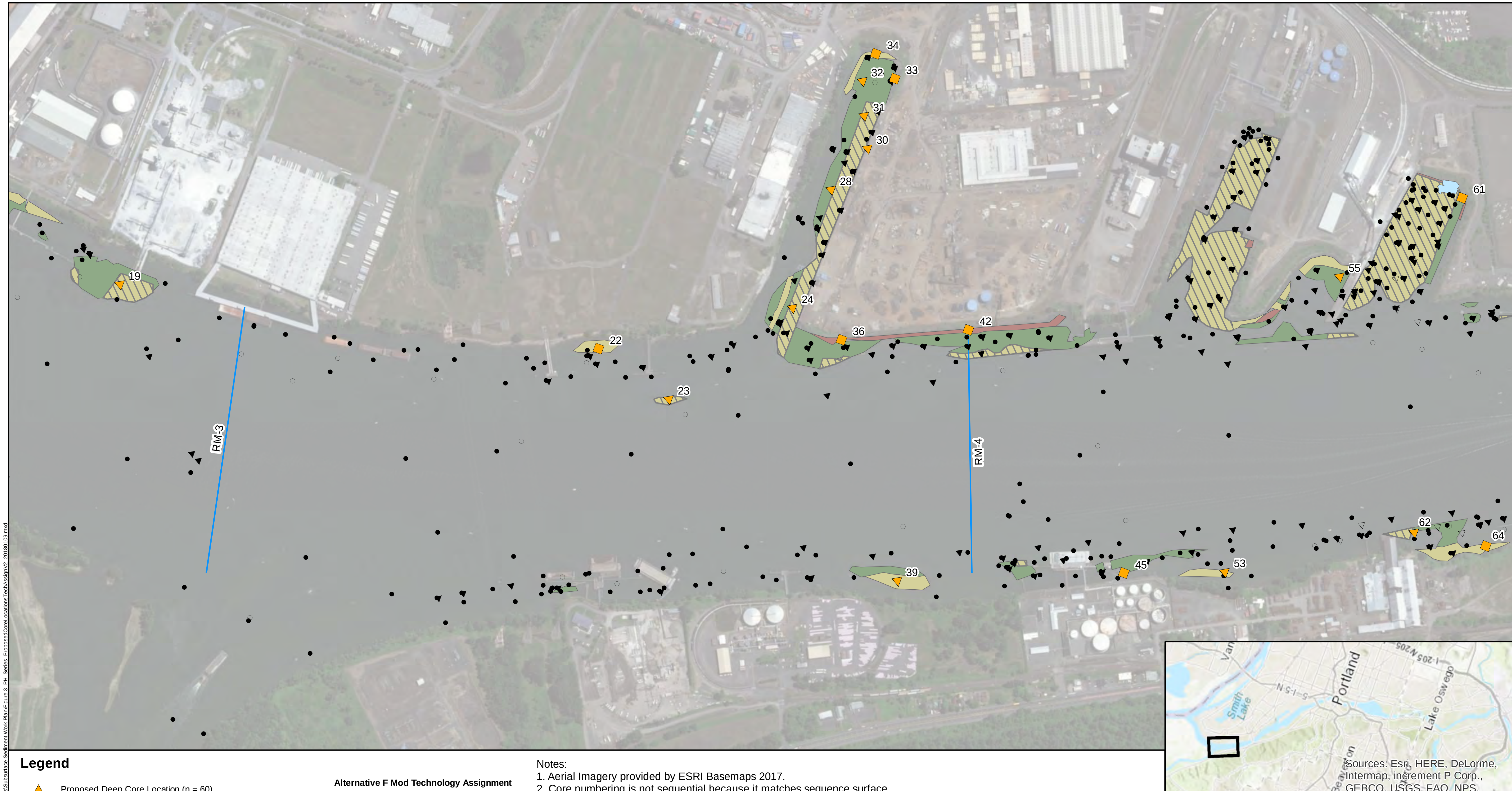
Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 1.9 to 3.3

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

AECOM Geosyntec consultants

Figure 3a

MI/SEA | January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

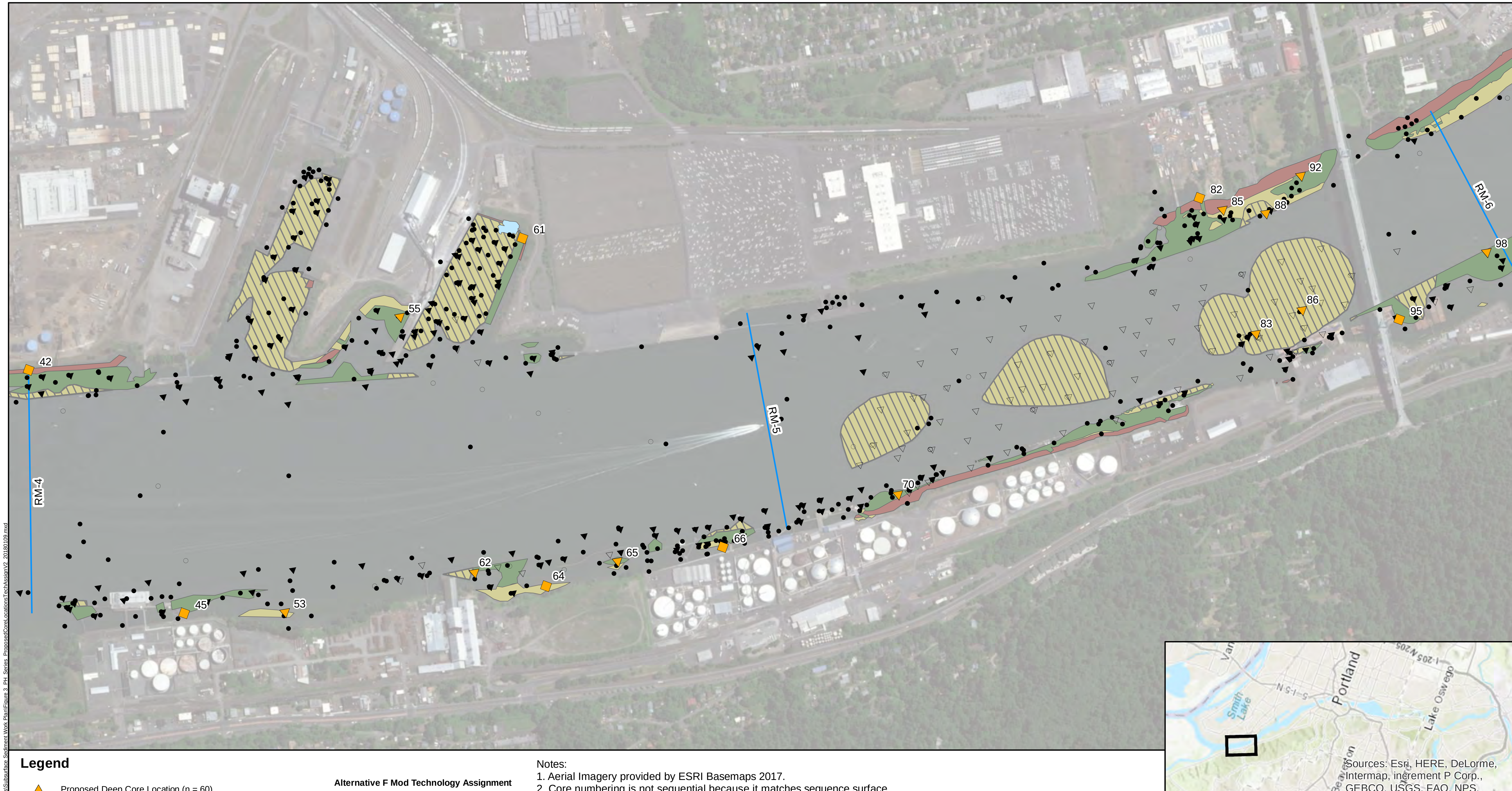
500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 3.3 to 4.2

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

AECOM Geosyntec consultants

Figure 3b	
MI/SEA	March 23, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

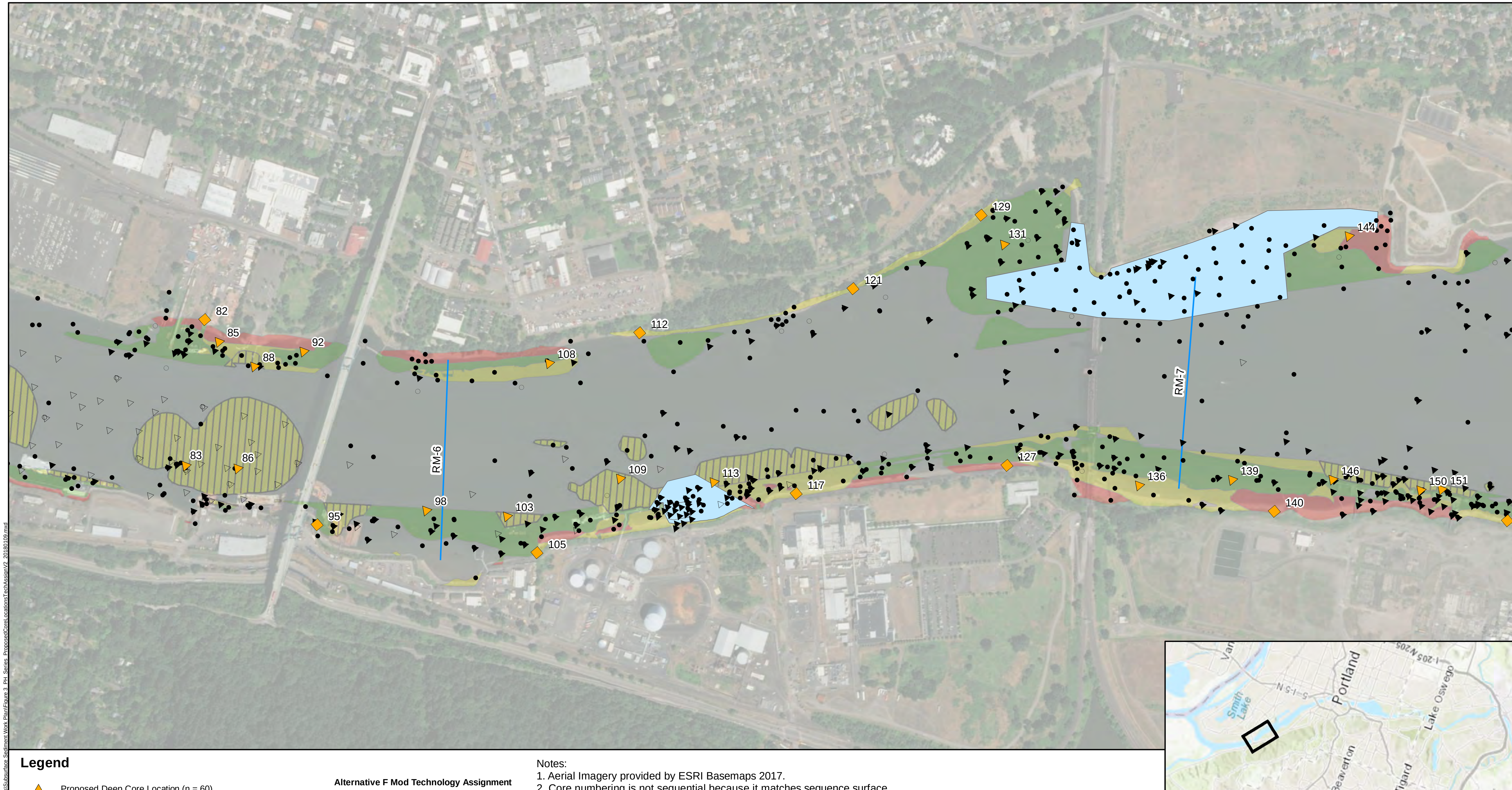
Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 4.2 to 5.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

AECOM
Geosyntec consultants

Figure **3c**

MI/SEA
March 23, 2018



Legend

- ▲ (orange) Proposed Deep Core Location (n = 60)
- ■ (orange) Proposed Shallow Core Location (n = 30)
- ▲ FS Subsurface Core Location
- ● FS Surface Sediment Sample
- △ Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- ○ Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 5.8 to 7.0

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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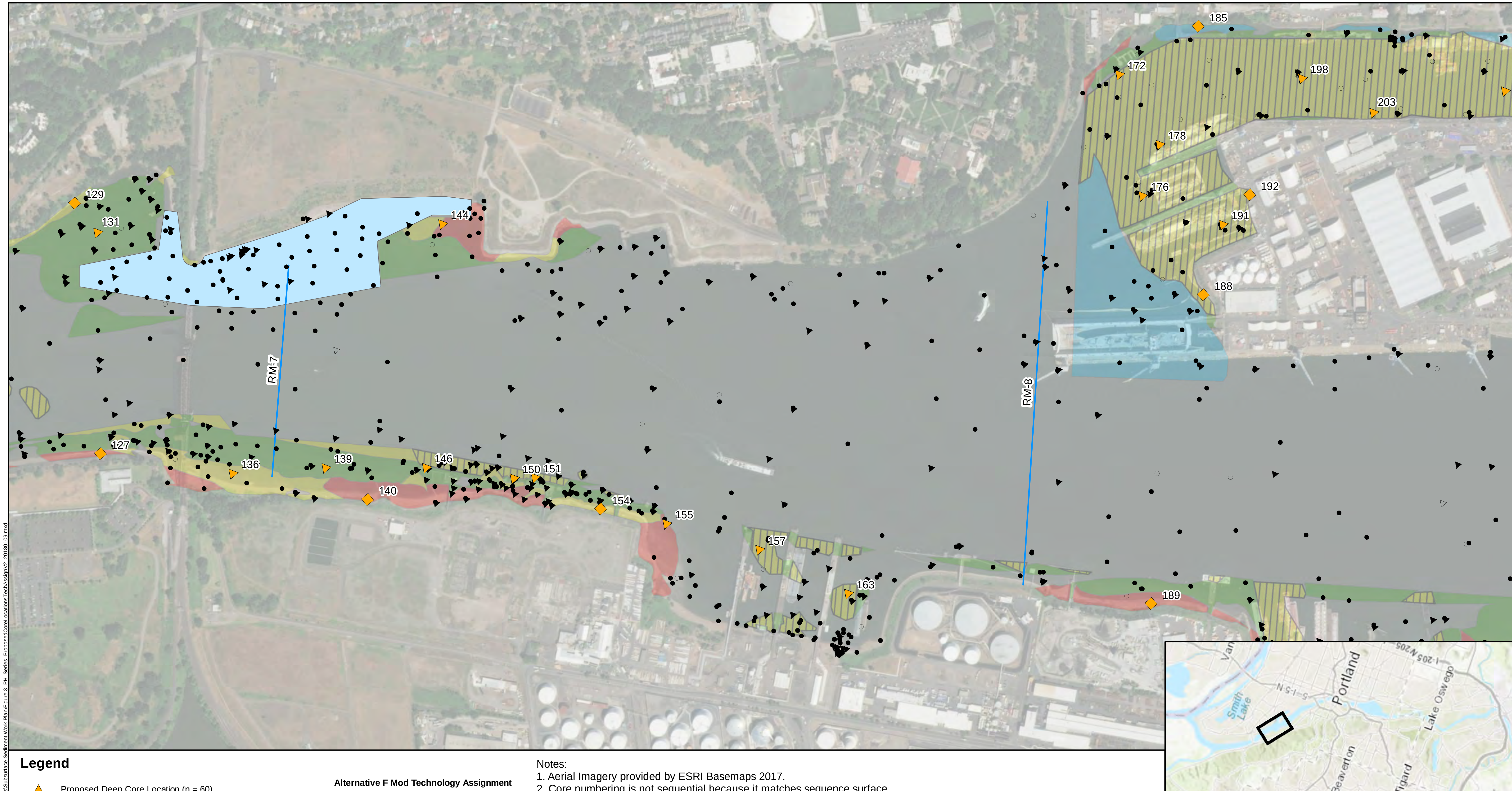
Figure 3d

MI/SEA | January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 7.0 to 8.2

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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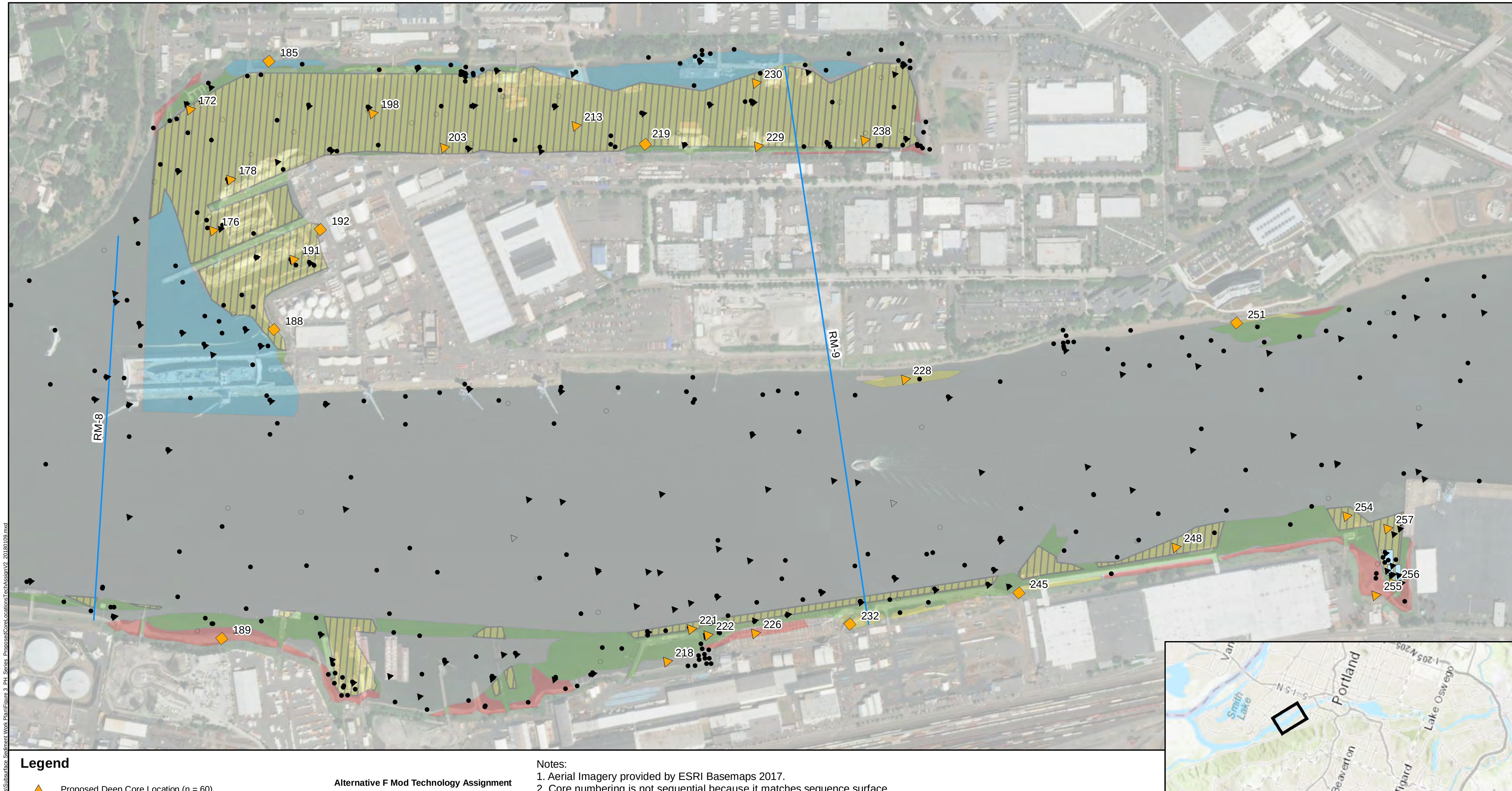
Figure 3e

MI/SEA | January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations RM 8.2 to 9.5

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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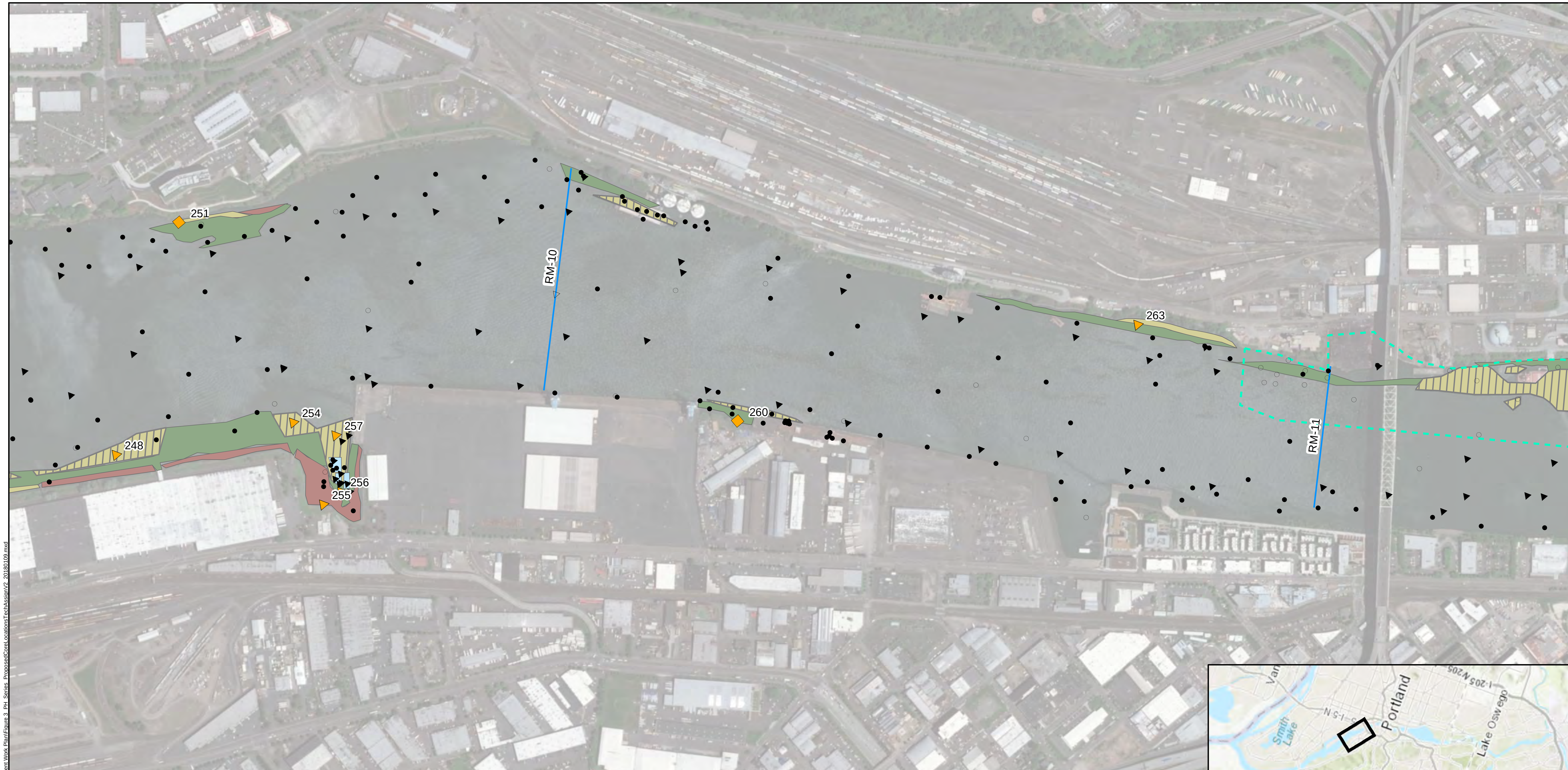
Figure **3f**

MI/SEA
January 18, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR
- Approximate RM 11E Early Action Area

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 9.5 to 10.6

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

AECOM
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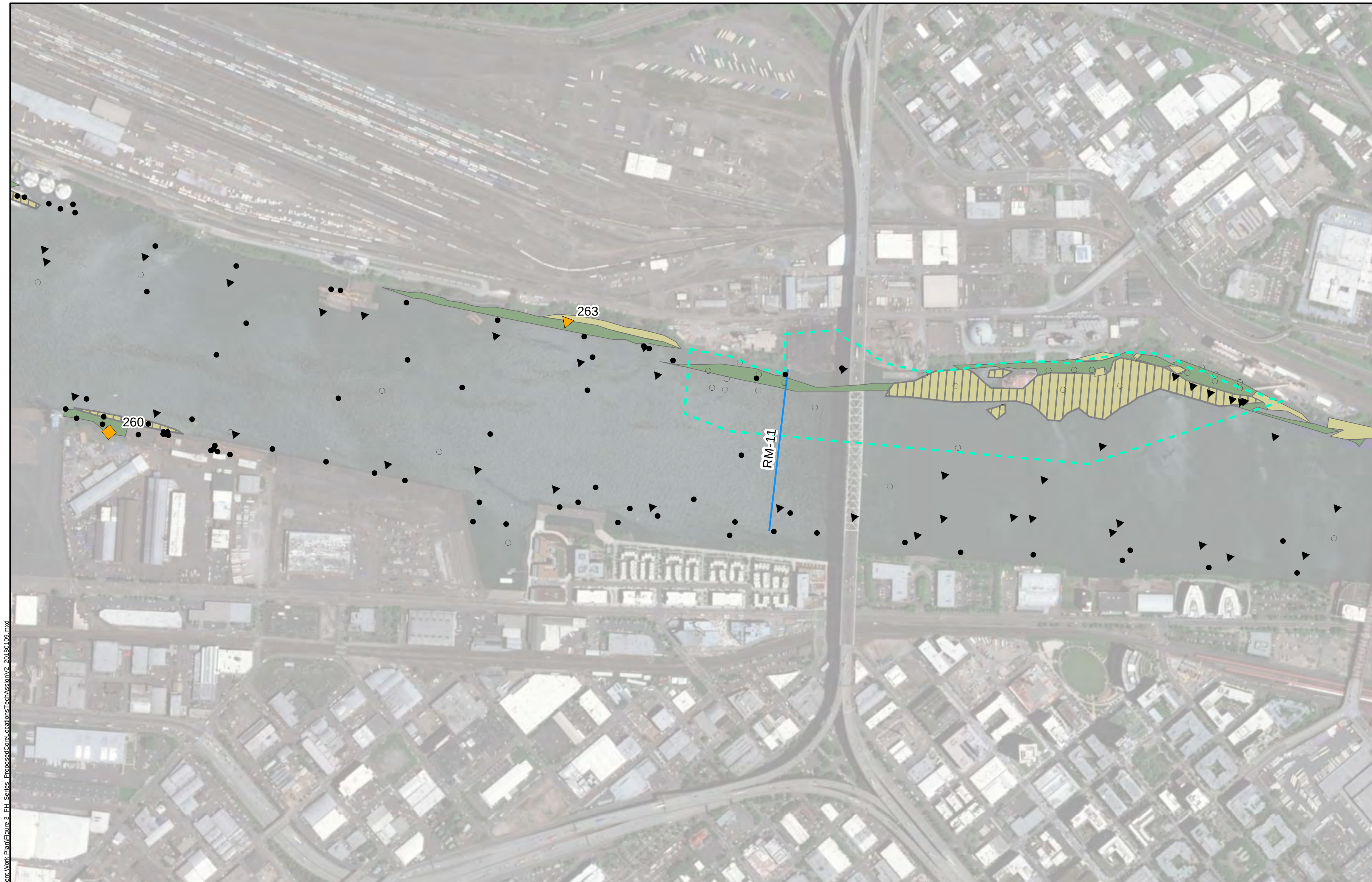
Figure
3g

MI/SEA
March 23, 2018



Legend

- Proposed Deep Core Location (n = 60)
- Proposed Shallow Core Location (n = 30)
- FS Subsurface Core Location
- FS Surface Sediment Sample
- Post RI/FS Subsurface Surface Sediment Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- Capped Area (Existing)

Alternative F Mod Technology Assignment

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR
- Approximate RM 11E Early Action Area

Notes:
1. Aerial Imagery provided by ESRI Basemaps 2017.
2. Core numbering is not sequential because it matches sequence surface grab ID scheme from downstream to upstream.
Only Subsurface Deep Cores and Shallow Cores shown.
4. Alternative F Mod technology assignments are hand digitized based on georeferenced imagery and may not exactly match ROD footprint at finer scales
5. Record of Decision for Alt F Mod footprint (EPA 2016).
6. n - sample count, RM - river mile.
7. References:
FS samples obtained from USEPA, 2016.
Post RI/FS samples compiled from: GSI Water Solutions and Hart Crowser, 2008; GSI Water Solutions and Hart Crowser, 2010; GSI Water Solutions Inc., 2014; Kleinfelder, 2015; NewFields, 2016; and Geosyntec, 2016.

N

500 250 0 500 1,000 Feet

Proposed Subsurface Sediment Sampling Locations and Historical Locations
RM 10.6 to 11.8

Portland Harbor Superfund Site
PDI Subsurface Sediment Coring FSP

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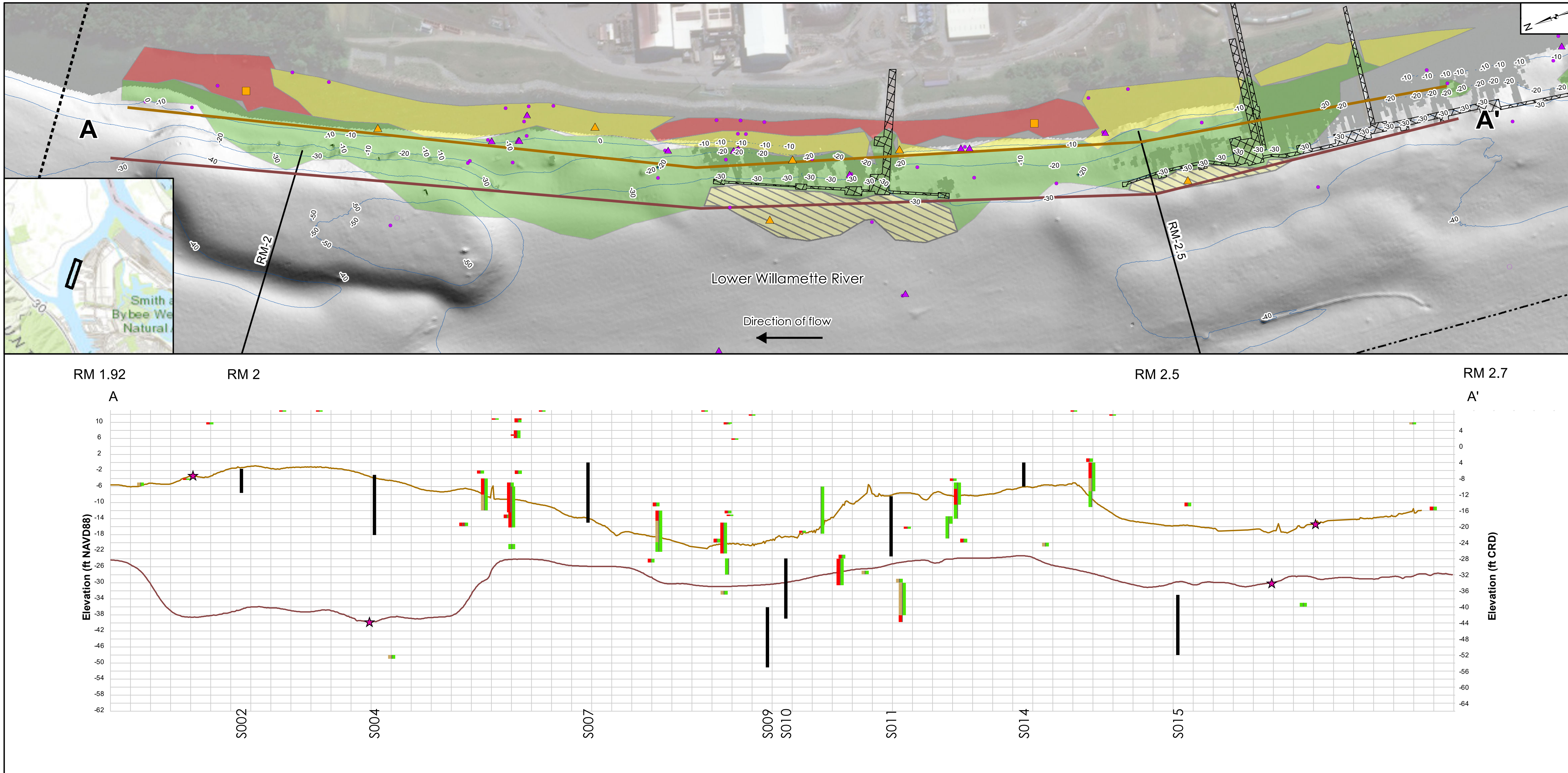
Figure 3h

MI/SEA March 23, 2018

Path: P:\Projects\Portland Pre-Design PN\G0767\A\900 GIS and CAD\MXDs\Subsurface Sediment Work Plan\Figure 3_PH_Series_ProposedCoreLocationsTechAssignV2_20180109.mxd



Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker

EPA Record of Decision (ROD) Table 17		
Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Shallow Mudline
- Approximate Toe of Slope Mudline
- Proposed Core Location and Grab RI Core Location and Depth
- Edge of Alt F Mod SMA Footprint

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. Samples and cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88.
3. Existing cores that are projected on the cross section may appear above or below the mudline elevation line(s); these are artifacts of the projection. The mudline elevations in the lower panel are drawn from the bathymetric contours in the upper panel.
4. Aerial Imagery provided by ESRI Basemaps 2017.

10X Vertical Exaggeration
0 200 400 800 Feet

Section A - A'

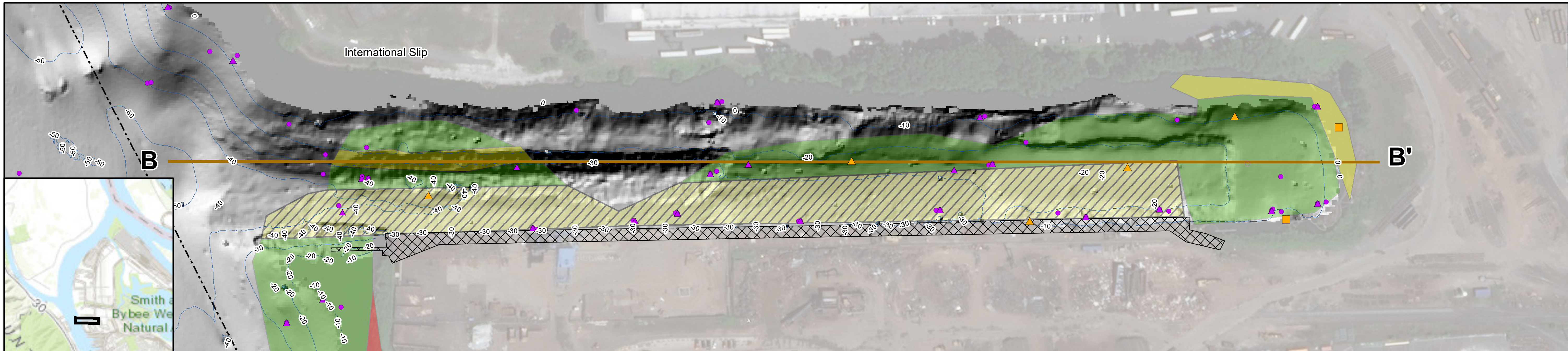
Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

AECOM Geosyntec consultants

Figure 4a

SS/JR | 18-Jan-2018

Path: P:\GIS\PortlandHarbor\Workplan\GIS\FSP\PHSS_XSection_A.mxd



Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker

EPA Record of Decision (ROD) Table 17		
Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Mudline
- Proposed Core Location and Grab RI Core Location and Depth
- Edge of Alt F Mod SMA Footprint

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. Samples and cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88.
3. Existing cores that are projected on the cross section may appear above or below the mudline elevation line(s); these are artifacts of the projection. The mudline elevations in the lower panel are drawn from the bathymetric contours in the upper panel.
4. Aerial Imagery provided by ESRI Basemaps 2017.

10X Vertical Exaggeration
0 100 200 400 Feet

Section B - B'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

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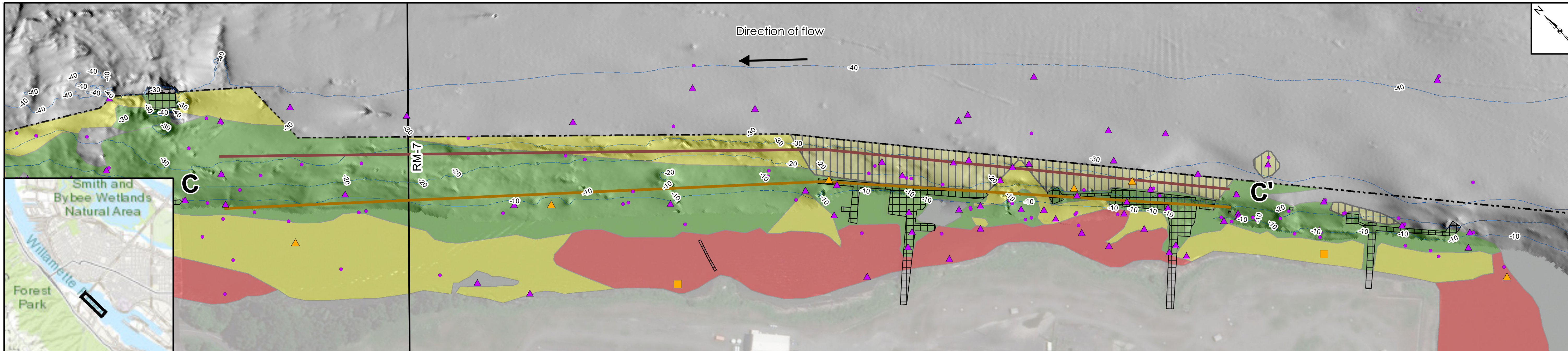
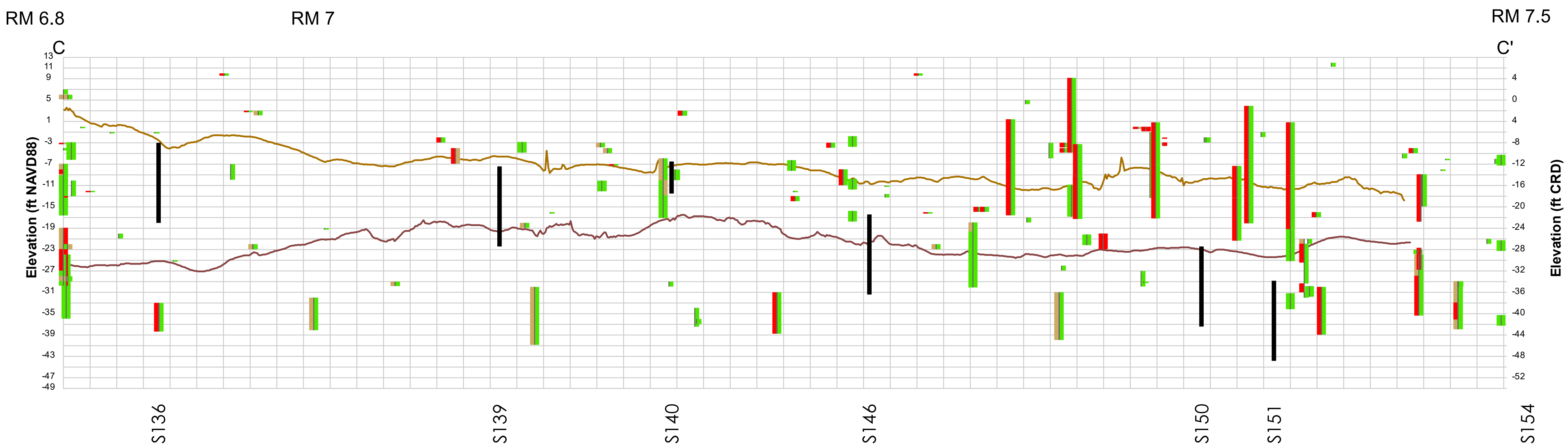
Figure **4b**

SS/JR 18-Jan-2018





Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge
- Dredge in Nav-FMD
- Dredge with Cap
- Cap

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker

EPA Record of Decision (ROD) Table 17		
Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Shallow Mudline
- Approximate Toe of Slope Mudline
- Proposed Core Location and Grab RI Core Location and Depth

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. RIFS cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88.
3. Existing cores that are projected on the cross section may appear above or below the mudline elevation line(s); these are artifacts of the projection. The mudline elevations in the lower panel are drawn from the bathymetric contours in the upper panel.
4. Aerial Imagery provided by ESRI Basemaps 2017.

10X Vertical Exaggeration

0 200 400 800 Feet

Section C - C'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

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SS/JR | 18-Jan-2018

Figure **4c**

Path: P:\GIS\PortlandHarbor\Workplan\GIS\XS\PHSS_XSection_C.mxd

Plan View

- Proposed PDI Shallow Core Location (n = 30)
- Proposed PDI Core Locations (n = 60)
- Post RI/FS Core Location (2013 to 2016)
- Post RI/FS Surface Sediment Sample Location (2013 to 2016)
- RIFS Subsurface Sediment Sample
- RIFS Surface Sediment Sample

ROD Alt F Mod SMA Footprint

- Dredge in Nav-FMD
- Dredge with Cap
- Cap
- EMNR

- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)
- River Mile Marker

EPA Record of Decision (ROD) Table 17		
Focused COC in Sediment	Clean-up Level (µg/kg)	RAL (µg/kg)
PCB	9	75
PAH	13,000	23,000

Side View

PCB (µg/kg)

- ≤ 9
- > 9 - 75
- > 75

PAH (µg/kg)

- ≤ 13,000
- > 13,000 - 23,000
- > 23,000

- Mudline
- Proposed Core Location and Grab RI Core Location and Depth
- Edge of Alt F Mod SMA Footprint

PCB (Left) PAH (Right)

Notes:
µg/kg - micrograms per kilogram
ft CRD - feet Columbia River Datum
FMD - Future maintenance dredge area
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyls
PDI - Pre-remedial design investigation
RAL - Remedial Action Level

1. RIFS cores are projected within 300 feet offset of section line.
2. Add 5.38 to convert CRD elevations to NAVD88.
3. Existing cores that are projected on the cross section may appear above or below the mudline elevation line(s); these are artifacts of the projection. The mudline elevations in the lower panel are drawn from the bathymetric contours in the upper panel.
4. Aerial Imagery provided by ESRI Basemaps 2017.

10X Vertical Exaggeration

0 200 400 800 Feet

Section D - D'

Portland Harbor Superfund Site
PDI Subsurface Sediment Core FSP

AECOM Geosyntec consultants

Figure 4d

SS/JR 18-Jan-2018

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APPENDIX A

Equipment Checklist, Field Forms, and Sediment Logging Key

A-1. Equipment Checklist

A-2. Field Forms

A-3. Summary of the ASTM Visual-Soil Classification Method and Sediment Sample Logging Key

Appendix A-1 Portland Harbor PDI
Sediment Sampling Equipment List

Safety Equipment
GPS
Cell phones (fully charged) or Satellite phone (if no cell coverage)
VHF radios
Rescue rope in throw bag
Air horns and/or whistles
Waterproof flashlight
Secondary “kicker” motor or alternative propulsion
Bailer or bilge pump/emergency pump
Length of rope for securing boat
US Coast Guard approved Type III or V PFD or life jacket
Type 4 throwable ring or cushion
Type BC fire extinguisher (10 pound) if extra fuel is carried in portable containers.
Anchor with appropriate length of line
First-Aid Kit and AED
Oil booms
PID
Bottled water
Snacks
Float plan

PPE
Boots, waterproof, steel-toed
Gloves, nitrile, heavy outer
Gloves, nitrile, thin inner
Hard hats
Hearing protection
Rain slicks
Safety glasses/goggles
Butcher apron or Tyvek for decon
Warm/dry clothes

Sample Handling
Vibracore sampler, core and tubes [1]
Hydraulic power grab sampler [2]
Bowls, large, stainless
Spoons, small, stainless
Spoons, large, stainless
Bottleware, sample analyses specific
Sample labels
core caps [1]
core catchers [1]

Plans
Field Sampling Plan [3]
Maps
Health and Safety Plan
Quality Assurance Program Plan

Tools
Hacksaw and Circular saw [1]
Extension cord and power strip [1]
Drywall blade, 6”
Ruler (12 inch/30 cm)
Measuring tape (with 1/10 inch increments) [1]
Rubber mallet [1]
Screwdrivers (Phillips, flat)
Siphon tubes [2]
Utility knife
Lead line (if not on vessel)

Supplies
Handheld GPS, fully charged
Camera
Gas for boat, if applicable
Keys for boat, if applicable
White board, white board markers
Bags, plastic zip, gallon-size
Bags, plastic zip, quart-size
Duct tape, electrical tape, and packing tape
Plastic sheeting
Ice
Logs, field [3]
Field books
Paper towels
Pens, ballpoint, permanent [3]
Sharpies, small and large
Trash bags
Zip ties
4” pipe clamps
Core carrying box
Peristaltic Pump

Decon Equipment
Brushes, long-handled
Brushes, short-handled
Detergent, laboratory (e.g., Alconox) Methanol/ hexane in dispensing bottle (optional) Nitric acid, 10% in dispensing bottle (optional) 5 gallon buckets, or similar
Aluminum foil
Water, distilled in dispensing bottle

Notes:
1: Subsurface Coring specific equipment
2: Surface grab sampling specific
3: Write-in-Rain waterproof paper/pens are recommended

Appendix A-2 Portland Harbor PDI Sediment Core Collection Log

Core Location #:______________
Core Collection Date:___/____/____

GPS Location Code:	
Weather Conditions:	
Water Level (CRD)**:**	
Water Depth (ft)**:**	
Mudline Elevation(ft)**:**	
Sampling Type (vibracore, tube ID):	
Proposed Coordinates:	N: E:

Sampling Personnel:
Field:
Contractor:

Core Tube Length:

Drive Length:

Recovery Length:

Percent Recovery:

Core Location and Attempts

Attempt #	**Time**	**Actual Coordinates**		**Penetration Depth** (ft)	**Recovery Length** (ft)	**Recovery** (%)	**Drive Description** (free fall, fingers inverted, vibration needed to drive/extract, debris encountered, refusal, etc):	**Accepted** (Y/N)
		Northing	**Easting**					

Visual Drawing Core Headspace and Sediment Inside Tube

Core Tube Length (ft):

Shoe

Section:	Length (ft):	Description at Cuts:
A =		
B =		
C =		
D =		
E =		
Shoe =		

EPA Oversight During Sample Collection? No Yes

Additional Comments

Note: percent compaction = recovery depth / drive depth

Appendix A-2 Portland Harbor PDI Sediment Core Processing Log

Core Location #:______________
Core Collection Date:___/____/____

Processing Date:			**Core Processing Personnel:**
Core Sample/Station ID:			
Analytical Suite (circle one):	Four Focused COCs		

Sediment Description											
Recovered Length (ft)	**% Compaction**	**Color**	**Size % - G**	**Size % - S**	**Size % - F**	**Description** (moisture, density, color, grain size, sheen/odor, biota/debris)	**PID Reading**	**In situ Actual Depth** (ft)	**Sample Depth** (ft)	**Subsample No.**	**Summary Sketch**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

*Use line weights indicated in logging key to illustrate major/minor contacts.
percent compaction = recovery depth / drive depth

Primary Sample Information					
Subsample ID	**Time**	**Containers**	**Subsample ID**	**Time**	**Containers**

EPA Oversight During Sample Processing? No Yes

Additional Comments

Appendix A-2 Portland Harbor PDI Sediment Core Processing Log

Core Location #:______________
Core Collection Date:___/____/____

Processing Date:	
Core Sample/Station ID:	
Analytical Suite (circle one):	

Core Processing Personnel:

Four Focused COCs

Sediment Description											
Recovered Length (ft)	% **Compaction**	**Color**	**Size % - G**	**Size % - S**	**Size % - F**	**Description** (moisture, density, color, grain size, sheen/odor, biota/debris)	**PID Reading** (ppm)	**In situ Actual Depth** (ft)	**Sample Depth** (ft)	**Subsample No.**	**Summary Sketch**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											

*Use line weights indicated in logging key to illustrate major/minor contacts.
percent compaction = recovery depth / drive depth

Primary Sample Information					
Subsample ID	**Time**	**Containers**	**Subsample ID**	**Time**	**Containers**

EPA Oversight During Sample Processing? No Yes

Additional Comments

MAJOR DIVISION			GROUP SYMBOL	LETTER SYMBOL	GROUP NAME
COARSE GRAINED SOILS CONTAINS MORE THAN 50% FINES	**GRAVEL AND GRAVELLY SOILS** MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE	GRAVEL WITH <u>5% FINES</u>		GW	Well-graded GRAVEL
				GP	Poorly graded GRAVEL
		GRAVEL WITH BETWEEN 5% AND 15% FINES		GW-GM	Well-graded GRAVEL with silt
				GW-GC	Well-graded GRAVEL with clay
				GP-GM	Poorly graded GRAVEL with silt
				GP-GC	Poorly graded GRAVEL with clay
		GRAVEL WITH ≥ 15% FINES		GM	Silty GRAVEL
				GC	Clayey GRAVEL
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> ON NO. 4 SIEVE	SAND WITH <u>5% FINES</u>		SW	Well-graded SAND
				SP	Poorly graded SAND
		SAND WITH BETWEEN 5% AND 15% FINES		SW-SM	Well-graded SAND with silt
				SW-SC	Well-graded SAND with clay
				SP-SM	Poorly graded SAND with silt
				SP-SC	Poorly graded SAND with clay
		SAND WITH ≥ 15% FINES		SM	Silty SAND
				SC	Clayey SAND
FINE GRAINED SOILS CONTAINS MORE THAN 50% FINES	SILT AND CLAY	LIQUID LIMIT <u>LESS</u> THAN 50		ML	Inorganic SILT with low plasticity
				CL	Lean inorganic CLAY with low plasticity
				OL	Organic SILT with low plasticity
		LIQUID LIMIT <u>GREATER</u> THAN 50		MH	Elastic inorganic SILT with moderate to high plasticity
				CH	Fat inorganic CLAY with moderate to high plasticity
				OH	Organic SILT or CLAY with moderate to high plasticity
HIGHLY ORGANIC SOILS				PT	PEAT soils with high organic contents

Notes

1. Sample descriptions are based on visual field and laboratory observations using classification methods of ASTM D2488. Where laboratory data are available, classifications are in accordance with ASTM D2487.
2. Same percentage distribution and group name method applies to fine-grained soils and % of sand and gravel it contains.
3. Fines are material passing the U.S. Std. #200 Sieve.

AECOM
Geosyntec consultants

PDI Portland Harbor Superfund Site
Pre-Remedial Design and Baseline Sampling
Portland, OR

Appendix A-3:
Summary of the ASTM Visual-Soil Classification Method

Portland Harbor PDI Sediment
Sample Logging Key

Visual Sediment Descriptions consist of the following:

- Moisture content
- Density/consistency (estimated based on visual observation)
- Color (Munsell Number)
- Major/Minor Contituents
- Amount and shape of minor constituents and major constituent structure
- Sheen and odor
- Redox potential discontinuity

Example: wet, soft, olive green (GLEY 1, 5/10Y) clayey SILT, little sand, moderate shell fragments, and trace twigs and rootlets. Silt texture is uniform, slightly compressible, massive, blocky, and of low plasticity. Slight odor and trace sheen. RPD 1 cm.

Sediment Description

Estimated based on visual observations

Terminology: ***Moisture Content***

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content, no visible water
Wet	Visible free water, probably above optimum

"Density": Visual Core Drive Penetration

SAND or GRAVEL		SILT or CLAY
Estimated Density	**Visual Observation during drive**	**Consistency**
Very loose	freefall	Very soft
Loose	easy penentration	Soft
Medium dense	moderate penentration	Medium stiff
Dense	hard/slow penentration	Stiff
Very dense	refusal	Very Stiff/Hard

MAJOR and Minor Constituent % (by weight)

Core Logs	Percent	Field Logs
Trace (clay, silt, etc.)	0–5	not identified
Few (clay, silt, etc.)	5-15	Slightly clayey, Slightly silty, etc.
Little (clay, silt, etc.) Clayey,	15-30	Clayey, silty, sandy, gravelly
silty, sandy, gravelly	30-50	Very clayey, Very silty, etc.
GROUP NAME	> 50	GROUP NAME

Structure

Stratified	Alternating layers of varied material/color at least 1/4" thick
Laminated	Alternating layers of varied material/color at least 1/4 mm thick
Blocky	Cohesive soil that can be broken down into smaller lumps
Spongy	Organic and compressible nature
Lensed	Inclusion of thin discontinuous layers of different sediment
Homogenous/Massive	Same color and appearance throughout
Fibrous	Stringy or rope like structure
Seam Layer	1/16 to 1/2" thick
Interbedded	greater than 1/2" thick
Rolls Easily	Multiple beds within a unit
Angular	Play-dough like (plasticity observation) Sharp edges
Subangular	Rounded edges
Subrounded	Well-rounded edges
Rounded	Smoothed, no edges

Other Minor Constituents: % (by volume)

(i.e., shells, wood, organics, plastic, non-native debris)

Trace	0-5
Scattered	5-10
Moderate	10-30
Substantial	30-50
GROUP NAME	> 50

Odor Descriptions add "like"

none
trace
slight
moderate
strong

Sheen Test- % coverage

S.T. = Sheen test visual analysis	
none, trace	<2
slight sheen	2-15
moderate sheen	15-40
moderate to heavy	40-70
heavy	>70

Sheen Test- Visual Description

rainbow	multicolored
metallic	metallic gray-colored
florets	semi-circular and multicolored
streaks	long and flowing shape

Other Sediment Descriptions Used

Agglomerate	Fused-appearance, often vesicular
Clast/inclusion	Non-fused appearance
Xenoclasts	Clasts that have been moved
Fresh	No visible sign of decomposition or discoloration
Winnowed	Loss of fines
Slumped	Settled but intact
Pockets/balls	Semicircular to circular inclusion/deposit
Chunky	Mass of unidentified material

Sediment Core Log Guidelines

------------	color or minor change
————	major sediment change
━━━━	depositional change

Grab Acceptance Guidelines

1. No or minimal excess water leaking from the jaws of the sampler.
2. No excessive turbidity in the overlaying water of the sampler.
3. Sampler did not over-penetrate.
4. Sediment surface appears to be intact with minimal disturbance.
5. Program-specific penetration (30 centimeters) has been achieved.

Core Acceptance Guidelines

1. Desired drive/penetration depth is reached.
2. Core recovery is greater than 80%.
3. Core tube appears intact (no signs of blocking, bending).
4. Minimal sediment loss out the top or bottom (minimal winnowing).

NOTES:

*Classification of sediment on core logs is based on visual field observations.
Classification notes should not be construed to imply laboratory testing unless presented herein. Unified Soil Classification System ASTM D-2487 and Visual-manual classification method ASTM D-2488 for the description and identification of soils were used as an identification guide.

APPENDIX B

Standard Operating Procedures

B-1. Hydrocarbon Field Screening by Sheen Test and Field Description Key for Potential NAPL in Sediments

B-2. Surface Sediment Sampling and Processing (Integral 2004)

B-3. Horizontal and Vertical Station Control

B-4. Round 2 FSP Excerpt of PID Field Screening (Integral 2004)

B-5. Management of Investigation-Derived Waste

Appendix B-1
Standard Operating Procedure
Hydrocarbon Field Screening by Sheen Test

1.0 Purpose and Applicability

The Standard Operating Procedure (SOP) for sheen test describes a procedure to visually estimate areas of possible hydrocarbon impacts in soil or sediment. In addition, screening results can be used to aid in the selection of soil/sediment samples for chemical analysis. The field screening method includes a visual examination and water jar screening test.

Visual screening consists of inspecting the soil/sediment for stains, nonaqueous-phase liquids (NAPL), and/or sheens indicative of residual hydrocarbons. Visual screening is most effective at detecting heavy hydrocarbons, such as creosote, free-phase NAPL or high hydrocarbon concentrations. Water sheen screening from a representative soil/sediment sample is a more sensitive method at detecting the presence of hydrocarbons.

2.0 Responsibilities

The project manager is responsible for ensuring that a properly designed sampling program is prepared prior to any sample collection. The field sampling coordinator will have the responsibility to oversee and ensure that all sampling is performed in accordance with the project-specific sampling program and this SOP. In addition, the field sampling coordinator must ensure that all field workers are fully apprised of this SOP.

3.0 Health and Safety

This section presents the potential hazards associated with this technique. The site-specific Health & Safety Plan (HASP) will take precedence over this document. Note that sample collection usually requires Level D personal protection unless there is a potential for airborne or dermal exposures to site contaminants.

Health and safety hazards include but are not limited to the following:

- Dermal exposure to potentially contaminated media: proper personal protective equipment (PPE) is used to mitigate dermal contact including the impact of splashes of water or media to skin and/or eyes;
- Inhalation exposure when handling impacted media: respiratory protection should follow the procedures outlined in the project Site-Specific HASP; and
- Broken glass, in the event that a glass jar is used: use care when handling glassware.

4.0 Supporting Materials

The following materials must be on hand in sufficient quantity to ensure that proper screening procedures may be followed:

- Approximately one cubic-inch of media to be screened;
- 4 of 8 oz. wide-mouth, clear glass jar;
- Stirring devise (i.e. spoon);
- Squirt bottle; and
- Supply of distilled water.

5.0 Methods and Procedures

The strategy used to collect soil/sediment samples in the field for sheen testing will depend on the nature/grain size of the material and the type of hydrocarbon. Discrete samples may be collected from specific depths where NAPL is likely to occur. When lithology is course-grained material over fine-grained material, then a sample should be collected just above this interface where NAPL may be pooling above the "aquitard". Similarly, where fine-grained material overlies a coarse-grained layer with suspected impacts, the sample should be collected just below the contact. When lithology is fine-grained, then a sample should be collected near the contact with the coarse-grained layer. Alternatively, when lithology is finely bedded (< 1-inch thick), then homogenized samples may be collected over a larger depth interval to gain an "average" observation.

If the sample is being collected from inside a sediment core tube, the tube should be cut open longitudinally along the length of the core tube to prevent additional smearing. Make sure the interior of the sediment is exposed as a "fresh surface". Be sure to discard any material along the inside side-walls of the core tube; this is called the "smear zone". The smear zone may mask the true stratigraphy of a subsurface core sample. Then, use a spoon to scrap material across the "fresh" surface of the depth interval of interest, and place into sample jars for further observation. Once the sample volume is collected (approximately 1 oz or more depending upon grain size) the sample is examined and tested as described below.

Visual Examination

In the field, observe sediment core tubes or soil samples for evidence of NAPL. Look at the material and note color and type/nature of occurrence. Observe the exterior and interio sidewalls of the sampling container for signs of staining. If wet, observe the nature of liquid. Among gravels, observe the surface of the gravel for signs of sheen and/or NAPL.

Water Sheen Test

Water sheen screening involves placing soil/sediment in a clear glass jar or a black plastic pan partially filled with water, and observing the water surface for signs of a sheen. The volume of soil/sediment required for observation is approximately one cubic inch, or 10 mls, or about one tablespoon of media. For practical application in the field or lab, place about one cubic inch of soil/sediment (roughly 1 oz) in a 4 to 8 oz jar filled ¼-full with water. For larger volumes, use about 2 oz of material in an 8 oz wide-mouth glass jar filled ¼-full with water. Even larger volumes are needed for gravel. A plastic baggy may be substitute for a glass jar if field conditions require. Crush the material in the jar using a stirring devise (i.e., spoon), and shake the sealed jar vigorously for 30 seconds and allow the material to settle. Observe the water surface and sidewalls of the jar for signs of sheen, LNAPL, and DNAPL. Quantify the amount of sheen and blebs in the water surface using the following sheen classification:

No Sheen	No visible sheen on water surface
Slight Sheen	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	Light to heavy sheen, may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas without sheen on water surface
Heavy Sheen	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen; visible droplets of immiscible liquids (i.e. NAPL)

Quantify the spatial coverage of sheen and size/diameter NAPL blebs if observed. The color is often described as rainbow or metallic for sheens and dark brown to black for blebs, droplets, and staining. Observe the sidewalls of the jar and estimate the thickness of LNAPL on the water surface and the thickness of DNAPL accumulated at the bottom of the jar. Record visual signs of staining on jar sidewalls and stirring devise.

Field screening results will be recorded on the field logs forms or in a field notebook. Field screening results are site-specific and location-specific. Factors that may affect the performance of this method include: operator experience (experimentation may be required before routine screening is started) ambient air temperature, soil type, soil moisture, organic content, and type of hydrocarbon. Headspace screening may be collected to help correlate results and observations.

6.0 Quality Assurance/Quality Control

Not applicable.

7.0 Documentation

Documentation may consist of all or part of the following:

- Field sampling forms;
- Field log book; and
- Chain-of-custody forms.

Field records should contain sufficient detail to provide a clear understanding of how and where samples were collected. All documentation shall be placed in the project files and retained following completion of the project.

<u>Appendix B-1</u>

<u>Field Description Key for Potential NAPL in Sediment</u>

The intent of this field description key is to provide field personnel with guidelines for logging and observing sediment conditions associated with potential presence of Non-Aqueous Phase Liquid (NAPL) in a consistent and factual manner.

VISUAL DESCRIPTORS

The range of conditions that could exist in sediments include:

- **NAPL** (Non-Aqueous Phase Liquid) – a separate phase liquid that may be lighter than water (LNAPL) or denser than water (DNAPL). NAPL can have varying consistency (viscosity) and can range from non-viscous to highly viscous (taffy-like). NAPL observations should be accompanied by applicable olfactory with smell (see descriptors below) and other visual observations (e.g., color and viscosity). The visual appearance of NAPL should be noted using descriptors below as appropriate. If NAPL is identified, then a sheen or shake test should be completed as described in this SOP in the Hydrocarbon Field Screening by Sheen Test portion.
    - **Free Product –** the entirety of the pore space for a sample interval is saturated with NAPL. Care should be taken to ensure that the saturation described is not related to water in the sample. Depending on the viscosity, NAPL saturated materials may freely drain from a soil sample and should be documented accordingly.
    - **Present–** In some cases, NAPL may be present in the pore spaces, or some of the pore spaces, but not coating the soil grains. The NAPL occurrence may be greater than blebs but not freely draining (saturated) and not hydraulically continuous. In these cases, the appearance/abundance of the NAPL should be noted.
    - **Blebs or Globules–** discrete, multi-shaped NAPL in or on the soil matrix. Include additional descriptors to the extent practicable such as the approximate size (typically ranging in size from 0.01 to 0.05 inches in diameter) and quantity (number of blebs or qualitative estimate) to the extent practical.
    - **Coated –** soil grains are coated with NAPL – there is <u>not</u> sufficient NAPL present to saturate the pore spaces. Use modifiers such as light, moderate or heavy to indicate the degree of coating.
    - **Semi-solid NAPL–** NAPL that is present as a super viscous liquid and appears in a solid or semi-solid phase. The magnitude of the observed solid NAPL should be described (discrete granules, tarry balls, taffy-like, or a solid layer).
- **Sheen –** iridescent sheen. The sheen characteristics need to be described in the field log, including the color, and iridescent sheens need to be distinguished from bacterial sheens which tend to break up at angles on the water surface; whereas a non-bacterial sheen will be continuous and will not break up. Sheens can be described as:
    - Discontinuous sheen (i.e., spotty, streaks, florets) within a section of core and does not fill sediment pore spaces.

    - Continuous sheen (i.e., covering an area greater than 1 square inch) within a section of core but does not fill pore spaces. Describe percent cover.
- **Stained** – visible, unnatural discoloration of the soil, with no visible NAPL.

Other Visual Impacts and Descriptors

In many cases, observed NAPL may be associated with a particular stratigraphic layer (e.g, sand lamination, woody debris layer, gravel lense), gas bubble, or void; NAPL distribution in relation to stratigraphy must be described. What does the material look like immediately above and below the area with suspected NAPL (e.g, clay). Impacts should be described using other visual descriptors as well, as applicable. Descriptors may include, but not be limited to, color, consistency, thickness, viscosity, water content, associated stratigraphy, presence shell or wood fragments or other debris, does NAPL flow out of the core tube, does it appear more or less viscous than water, results of jar sheen test, etc. Also note the staining of sampling equipment, and interior and exterior side-walls of the sampling tube, especially if entrainment of NAPL up the side-walls is suspected as an artifact of sample collection.

OLFACTORY DESCRIPTORS

Field personnel will not conduct olfactory testing as part of sample processing, because vapor inhalation is a potential health and safety risk. However, if incidental odors are noted by field personnel during regular sample processing activities, field personnel will record this observation in the field forms. General descriptors that could be used are the following:

- Note odors similar to mothballs, driveway sealer, highway paving oil, sewage or other odors that are acrid, burnt, or sulfur-like, etc.
- Other odors that are not believed to be natural should also be identified with descriptors such as organic, ammonia, sweet, chemical etc., as applicable.
- Use modifiers such as strong, moderate or slight to indicate intensity of the observed odor.
- In instances where multiple odors are present, a combination of descriptors should be used to clearly identify where these co-mingled impacts are present.

However, olfactory descriptions are more subjective than visual inspections. Visual inspection may be aided by a PID, ultraviolet (UV) fluorescence examination, shake test, or similar device, to monitor and record organic odors and suspected NAPL in the field. One may also consider collecting a sample of the suspected NAPL to assess physical characteristics and potential mobility.

Last revised by AGF and Geosyntec on 1/18/18
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SURFACE SEDIMENT SAMPLING AND PROCESSING

The purpose of this standard operating procedure (SOP) is to define and standardize the methods for collecting surface sediment samples from freshwater or marine environments. For the purpose of this SOP, surface sediments are defined as those from 0 to at most 30 cm below the sediment-water interface. The actual definition of surface sediments is typically program-specific and is dependent on the purpose of the study and the regulatory criteria (if any) to which the data will be compared.

This SOP utilizes and augments the procedures outlined in Puget Sound Estuary Program (PSEP 1996) guidelines. A goal of this SOP is to ensure that the highest quality, most representative data be collected, and that these data are comparable to data collected by different programs that follow PSEP guidelines.

SUMMARY OF METHOD

Sediment samples for chemical and toxicity analysis are collected using a surface sediment sampling device (e.g., grab sampler). If a sample meets acceptability guidelines, overlying water is siphoned off the surface and the sediment is described in the field log. Sediment samples for chemical analysis may be collected directly from the sampler (e.g., volatile organic compounds and sulfides) or sediment from the sampler may be homogenized using decontaminated, stainless-steel containers and utensils prior to being placed in sample jars. Sediment from several sampler casts may also be composited.

SUPPLIES AND EQUIPMENT

A generalized supply and equipment list is provided below. Additional equipment may be required depending on project requirements.

- Sampling device:
  Grab sampler or box corer

- Field equipment:
  Siphoning hose
  Stainless-steel bowls or containers
  Stainless-steel spoons, spatulas, and/or mixer
  Decontamination supplies
  (Alconox™ detergent, 0.1 N nitric acid, methanol dionized water)
  Personal protective equipment for field team
  (rain gear, safety goggles, hard hats, nitrile gloves)
  First Aid kit
  Cell phone

Sample containers
Bubble wrap
Sample jar labels
Clear tape
Permanent markers
Pencils
Coolers
Ice

- Documentation

  Waterproof field logbook
  Field sampling plan
  Health and safety plan
  Correction forms
  Request for change forms
  Waterproof sample description forms

PROCEDURES

EQUIPMENT DECONTAMINATION

The basic procedure used most commonly in Integral field projects to decontaminate field sampling equipment is as follows:

1. Rinse with tap or vessel water.
2. Wash with brush and Alconox™ detergent.
3. Rinse with tap or vessel water.
4. Rinse with distilled water.
5. Rinse with 0.1 N Nitric acid (optional - if metals analysis is to be performed).
6. Rinse with methanol or hexane (optional - if organics analysis is to be performed or adhering petroleum residue present).
7. Rinse with distilled water.
8. Cover with aluminum foil (dull side down).

This procedure may be modified depending on site-specific requirements, as described in PSEP (1986). For example, if sampling is in areas known to be uncontaminated or only slightly contaminated, the solvent and/or acid rinses may be eliminated. Conversely, if creosote or other petroleum-based residue is encountered, a hexane rinse may be added.

Decontamination with acid or solvents should always be performed outdoors using appropriate protective equipment, including, at a minimum, chemical-resistant gloves (e.g., nitrile) and goggles. All decontamination liquids that include solvents or acids should be contained in tightly sealed buckets or other containers for disposal in an approved onshore facility. Alternatively, low-vapor pressure solvents may be evaporated in a well-ventilated open area away from the work zone.

SEDIMENT SAMPLE COLLECTION

To collect sediment for chemical and biological analyses, a sampler that obtains a quantifiable volume of sediment with minimal disturbance of the sediments must be employed. Additionally, the sampler should be composed of a material such as stainless steel or aluminum, or have a non-contaminating coating such as Teflon™. Samplers capable of providing high-quality sediment samples include grab-type samplers (van Veen, Smith-McIntyres, Young grab, power-grab and ponar grab) and box cores (Soutar, mini-Soutar, Gray-O'Hara, spade core). Some programs require a sampler that collects from a specific area (e.g., 0.1 m^2). Most sampling devices are typically a standard size; however, some non-standard sizes are available to meet the requirements of specific programs. Grab samplers, especially the van Veen grab, are the most commonly used samplers to collect surface sediment. Power grab samplers are often used for programs requiring collection of sediment deeper than 10 cm or in areas with debris.

A hydraulic winch system should be used to deploy the sampler at a rate not exceeding 1 m/sec to minimize the bow wake associated with sampler descent. Once the sampler hits the bottom, the jaws are slowly closed and the sampler is brought to the deck of the vessel at a rate not exceeding 1 m/sec to minimize any washing and disturbance of the sediment within the sampler. At the moment the sampler hits the bottom, the time, depth, and location of sample acquisition are recorded in the field logbook.

Once onboard, the sampler is secured, any overlying water is carefully siphoned off, and the sample is inspected to determine acceptability. Criteria used to determine acceptability are those detailed in PSEP (1986), except when noted in the project-specific field sampling plan (FSP). These criteria include but are not limited to:

- There is minimal or no excessive water leakage from the jaws of the sampler.
- There is no excessive turbidity in the water overlying the sample.
- The sampler is not over-penetrated.

- The sediment surface appears to be intact with minimal disturbance.
- The program-specified penetration depths are attained.

If the sample meets acceptability criteria, the sample is recorded and observations entered into a sample description form or log. Once the sample has been characterized, the sediment is then sub-sampled for chemical and biological analyses.

SAMPLE PROCESSING

Sediment for chemical and/or toxicity analyses is removed from the sampler using a stainless-steel spoon. Depending on programmatic goals, the upper 2 to 30 cm of sediment are removed. To prevent possible cross contamination, sediments touching the margins of the sampler are not used.

Samples for volatile compounds (either organics or sulfides) are collected using a decontaminated stainless-steel spoon while sediment is still in the sampler. These sediments are not homogenized. The volatile organics sample jar should be tightly packed with sediment (to eliminate obvious air pockets) and filled so that there is no headspace remaining in the jar. Alternatively, if there is adequate water in the sediment, the container may be filled to overflowing so that a convex meniscus forms at the top, and the cap carefully placed on the jar. Once sealed, there should be no air bubbles. The sulfides sample is preserved with 0.2 N zinc acetate.

The remaining sediment is then placed into a pre-cleaned, stainless-steel bowl. Typically, sediment from a minimum of three separate casts of the sampler is composited at each station. Once a sufficient amount of sediment has been collected, the sediment is homogenized until it is of uniform color and has obtained a smooth consistency. It is then dispensed into pre-cleaned sample jars for the various chemical or biological analyses. Sample jars for biological analyses should be filled to the top with sediment to minimize available headspace. This procedure will minimize any oxidation reactions within the sediment. Sample jars for chemical analysis may be frozen for storage, leaving enough headspace left in the container to allow for expansion of the sediment upon freezing. After dispensing the sediment, the containers are then placed into coolers with ice and are either shipped directly to the analytical laboratories or transported to a storage facility.

CHAIN-OF-CUSTODY

Field

The cruise leader or other designated field sample custodian is responsible for all sample tracking and chain-of-custody procedures until sample custody is transferred to the laboratory. Custody procedures in the field are as follows:

1. Record all field and sample collection activities (including sample identification number, collection time and date) in the field logbook. While being used in the field, the logbook remains with the field team at all times. Upon completion of the sampling effort, the logbook should be reproduced and then kept in a secure area.
2. Complete a chain-of-custody form whenever samples are being transferred or removed from the custody of field sampling personnel. A sample form is provided in Appendix B. Record each individual sample on the form. Include additional information to assist in sample tracking such as collection date and time, number of containers, and sample matrix. The chain-of-custody may also serve as the sample analysis request form, with the required analysis indicated for each individual sample.
3. Sign the form and ensure that the samples are not left unattended unless secured.
4. Store, pack, or ship samples as described in the following section. Place the original completed chain-of-custody form in a sealed plastic bag inside the shipping container. A copy is retained by the shipping party.
5. Complete a separate custody form for each individual shipping container or a single form for all samples in multiple shipping containers in a single shipment, with the number of containers noted on the custody form.
6. Attach completed custody seals to any shipping container that will be sent to the laboratory by delivery service or courier. Delivery personnel are not required to sign the custody form if custody seals are used. Custody seals are used to detect unauthorized tampering with the samples. Gummed paper or tape should be used so that the seal must be broken when the container is opened. The laboratory sample custodian (or other sample recipient) will establish the integrity of the seals.

7. The laboratory custodian (or other sample recipient) acknowledges receipt of the samples by signing, dating, and noting the time of transfer on the chain-of-custody form. The condition of the samples and any problems or irregularities (e.g., cracked or broken jars, loose lids, evidence of tampering) should also be recorded. Return a copy of the completed custody form to the project manger or designated sample coordinator.

Laboratory

The laboratory will designate a sample custodian who is responsible for receiving samples and documenting their progress through the laboratory analytical process. Each custodian will ensure that the chain-of-custody and sample tracking forms are properly completed, signed, and initialed on transfer of the samples. Specific laboratory chain-of-custody procedures should be in writing, included in the laboratory QA plan, and approved prior to beginning sampling and analysis. Laboratory custody procedures should include the following:

- A designated laboratory person initiates and maintains a sample tracking log that will follow each sample through all stages of laboratory processing and analysis.
- The laboratory tracking log includes, at a minimum, the sample number, location and type of storage, date and time of each removal, and signature of the person removing or returning the sample.
- The final disposition of the sample is recorded.

CHAIN-OF-CUSTODY QUALITY CONTROL PROCEDURES

Complete and correct chain-of-custody is essential to ensure and demonstrate sample integrity. Errors in entering information or transferring custody can result in analytical or data reporting errors. Inaccuracies or errors in sample tracking and custody records can compromise data usability, particularly as legal evidence.

Quality control procedures include the following:

- Allow adequate time to take accurate and complete field records and to carefully complete chain-of-custody forms.
- When possible, work in pairs or more to complete the chain-of-custody form and check for accurate information entry.

- Complete all custody records in ink; errors should be neatly crossed out and corrected and initialed by the person making the change.
- Immediately notify the project manager of any deviation from required custody procedures.

PACKING AND SHIPPING SAMPLES

Environmental samples are packed in a manner to reduce the chance of sample breakage, ensure sample integrity, and prevent material leakage and potential exposure to hazardous materials in the event of breakage. Samples are placed in sealed plastic bags and packed in a sturdy container with adequate packing material to prevent breakage. Ice or dry ice may be included to maintain sample storage conditions. Samples are transported by field personnel or shipped via courier or common carrier. Shipping procedures are in accordance with U.S. Department of Transportation regulations (49 CFR 173.6 and 49 CFR 173.24).

All preserved samples should be shipped as soon as possible after completion of sampling. This minimizes the number of people handling samples and protects sample quality and security.

Sample Packing

Upon completion of final sample inventory by the field sample custodian and completion of chain-of-custody, samples are packed as follows:

1. If not already done after sample collection, wipe the outside of each sample container and lid with a disposable cloth to remove any soil or sediment adhering to the outside of the jar and place each container in a sealed plastic bag (e.g., ziplock).
2. Wrap each glass sample container in bubble wrap or place it in a bubble wrap plastic bag. [Note: When samples are being transported by field personnel directly from the field site to the laboratory (thereby ensuring careful handling), this step is recommended but may be omitted. However, this step is required when a courier or delivery service is transporting the samples.]
3. Line the shipping container with heavy-duty plastic bags (e.g., garbage bags) and bubble wrap. Use a leak-proof, sturdy container that can withstand rough treatment during shipping. If ice chests or coolers are used, the drain should be securely plugged and sealed with duct tape.

4. Place the samples tightly in the shipping container:
   - Use dividers or bubble wrap to separate all glass containers
   - Fill any empty space in the shipping cooler or box with packing material so that the jars are held securely.

5. Place the original completed chain-of-custody form in a sealed plastic bag and place it inside the shipping container. If using a cooler or ice chest, the form should be securely taped to the inside of lid.
6. For liquid samples, absorbent material (e.g., vermiculite) should be placed in the container in sufficient quantity such that all liquid could be absorbed.
7. Tie or seal the bag lining the shipping container.
8. If required to meet sample storage requirements, fill the ice chest with crushed or block ice, blue ice (refrigerated samples, 4°C) or dry ice (frozen samples). A temperature blank (provided by the laboratory) should be packed in each cooler.
9. If samples for volatile organics analysis (VOA) are included in the shipping container, two VOA trip blanks (provided by the analytical laboratory) should also be packed in the cooler.
10. Seal shipping container securely with packing or duct tape.
11. If the shipping container will be transported by anyone other than the person who completed and signed the chain-of-custody form, attach completed custody seals so that the shipping container cannot be opened without breaking the seal.
12. Attach a *This End Up* label to each side of the shipping container to ensure that jars are transported in an upright position. A *Fragile* label may also be attached to reduce rough handling of the samples.
13. Label the shipping container with all appropriate information (name of project, time and date, responsible person and company name, address and phone) to enable positive identification.

Sample Shipping

Packed containers may be delivered to the laboratory or storage facility by field personnel, courier, or common carrier (FedEx, UPS). However, any outside carrier or courier service must provide a delivery receipt. The carrier or courier must also ensure delivery time if holding time and storage conditions are critical.

Unless arranged in advance, shipping charges should be prepaid by sender to avoid confusion and possible rejection of the package by the laboratory.

The adequacy of handling and shipping procedures is reflected in the condition of the samples upon receipt by the laboratory:

- No jars are cracked or broken.
- There is no evidence of sample leakage.
- Measuring the temperature of the temperature black indicates that correct storage conditions have been maintained.

The sample custodian or other designated person is responsible for confirming that copies of all shipping documents, completed in full and correctly, are on file at Integral.

QUALITY CONTROL PROCEDURES

Field quality control (QC) samples that may be collected during surface sediment sampling are the same as for any field sampling program. The types and frequency of field QC sample collection are project-specific and will be described in the project field sampling plan. The most commonly collected field QC sample are described below (PSEP 1996):

- **Field Blank**. A field blank is a sample of analyte-free water that is supplied by the laboratory. The field blank is generated by transferring the analyte-free water to another laboratory-supplied sample container while at the field sampling location. Field blank results are used to measure and document any possible onsite contamination.

- **Field Split Sample**. A field split sample consists of aliquots of the same homogenized sediment sample that are equally distributed in two sets of sample containers. These samples may be analyzed identically or analyzed by different laboratories to evaluate repeatability of sample handling and analytical procedures, sample heterogeneity, and analytical procedures.

- **Field Replicate**. A field replicate consists of a second sample that is collected using the same sampling methodology used to obtain the first sample. It is collected at the same sampling location and as soon after the original sample as possible. Analysis of the field replicate allows evaluation of the repeatability of field sampling methodologies, as well as the heterogeneity of the sample matrix. Statistical analysis of multiple replicates may also be used to calculate the likely range of an analyte concentration at a given sampling location.

REFERENCES

PSEP. 1996. Puget Sound Estuary Program: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Final Report. TC-3991-04. Prepared for U.S. Environmental Protection Agency, Region 10 and Puget Sound Estuary Program, Seattle, WA. Tetra Tech and HRA, Inc., Bellevue, WA.

SEDIMENT CORE COLLECTION AND PROCESSING

Sediment cores are collected to evaluate chemical and/or biological characteristics of surface and subsurface sediments at depths that greatly exceed those achieved by grab or other surface samplers. The purpose of this SOP is to define and standardize procedures for the collection of samples from surface and subsurface sediment cores. Additionally, this SOP will help ensure that the highest quality, most representative data are collected, and that these data are comparable to data from other programs. This SOP is based on the procedures outlined in Puget Sound Estuary Program guidelines (PSEP 1996).

SUMMARY OF METHOD

Sediment cores are collected using some type of coring device, including gravity corers, piston corers, vibracorers and diver-driven cores. Actual operations will vary depending on the equipment selected. Selection of the most appropriate corer usually depends on may factors, including but not limited to:

- The quantity of sample required
- The penetration depth required
- The sediment type (e.g. rocky, soft, compact)
- Vessel availability and capability (i.e. size, lifting capacity etc.).

Regardless of the coring method, the core tube should be constructed of a non-contaminating material such as stainless steel or aluminum, or should use a liner constructed of a non-contaminating material (e.g., polycarbonate).

Once the sediment core is collected, it is extruded or split so that the sediment can be sampled, processed, and transported to the analytical laboratory.

Supplies and Equipment

A generalized supply and equipment list is provided below. Additional equipment may be required depending on project requirements.

- Sampling device:
  - Corer
  - Core tubes
  - Core tube liners (optional)
  - Core tube caps

- Field equipment:
  - Aluminum foil
  - Duct tape
  - Hack saw
  - Indelible ink pen

Pipe cutter
Circular saw (if splitting tube longitudinally)
Plunger (if necessary)
Table or tray
Ice (if storing cores)
Stainless-steel bowls
Stainless-steel spoons, spatulas, and/or mixer
Personal protective equipment for field team
(rain gear, safety goggles, hard hats, nitrile gloves) First Aid kit
Cell phone
Sample containers
Bubble wrap
Clear tape
Permanent markers
Pencils
Coolers

- Documentation

 Core description forms or log book
 Waterproof field logbook
 Field sampling plan
 Health and safety plan
 Correction forms
 Request for change forms
 Waterproof sample description forms

CORE COLLECTION PROCEDURES

CORER DEPLOYMENT

Gravity and piston corers utilize inertia as the primary driving force to achieve the desired penetration depth. The degree of penetration can be altered by either adjusting the number of weights at the top of the tube or by changing the vertical distance that the core tube is allowed to free-fall. During descent, the corer should be lowered under power to its predetermined free-fall distance above the bottom. The lowering should be halted when this vertical distance equals the difference between the meter wheel reading and the fathometer reading.

If the device is equipped with a trip-weight or a small gravity trip-corer, the free-fall distance will equal the length of the core tube plus the vertical distance between the core cutter and the trip-weight suspended beneath it. When the trip-weight contacts the bottom, it relaxes the tension on the release mechanism and the core tube free-falls into the sediment. Consistent penetration depths can be obtained with this method, as the free-fall distance is independent of winch control and changing bottom depth.

The vibracorer uses a hydraulic system that vibrates and drives a length of aluminum tubing into the sediment. A continuous sediment sample is retained within the tubing with the aid of a stainless-steel core cutter/catcher. Coring can continue until the total sample depth is reached.

CORE RETRIEVAL

The core is extracted from the substrate and pulled onto the sampling vessel using the vessel winch or crane. The amount of pull that is required depends on the coring device and its contents, plus the amount of frictional force against the surface of the core tube that must be overcome. The frictional force depends on the sediment type (e.g. clay-based material requires more pull) and the depth penetrated (PSEP 1996). During core extraction, the wire strain should be steady and continuous, with the vessel held stationary directly above the coring device. Once the core is extracted from the bottom, the winch speed may be increased to about 4 ft/sec.

The core is brought on board the vessel. While the tube is still vertical, overlying water may be siphoned off the top of the core tube. Recovery is estimated to accurately determine the true depth from which the sediments were collected and the location of those sediments within the core barrel. In most cases, recovery is estimated by comparing the length of the sediment core material to the overall penetration depth (as indicated by traces of sediment material on the outer surface of the core tube). The ratio of penetration depth to core material length is calculated to determine the compaction of the sediment during coring. Alternatively, some vibracorers are equipped with a transducer to measure penetration depth. A second transducer is mounted directly above the core tube to determine the height of the sediment column within the core barrel. Recovery can be estimated from the difference between the two transducer readings. Recoveries typically range between 50 and 90 percent.

Continuous core lengths (such as those obtained by a vibracorer) may be sectioned into smaller lengths for ease of handling and/or to represent the desired sampling intervals. The core tube is placed on a secure surface and tightly anchored. Beginning at the top of the core tube, sample sections are marked on the outside of the core tube in indelible ink. Before the tube is cut, a label identifying the station and core section is securely attached to the outside of the casing at the top of each section, and wrapped with transparent tape to prevent loss or damage of the label. (Note that care should be taken when measuring core sections to consider core compaction.) Core sections may then be cut using a manual, heavy-duty pipe cutter.

After the tube is cut, sediment at the end of each tube section cut is visually classified for qualitative sample characteristics. Changes from the top to the bottom of each section of the tube are noted and recorded in the field log or core description forms. If the core section will be stored or transported, the core ends are then covered with aluminum foil, a protective cap, and duct tape to prevent leakage. Ideally, the core sections should be stored upright in a container chilled with ice to approximately 4°C. Empty tubing should be removed to help ensure that each section is full of sediment. This limits disturbance during storage and transport. If necessary, cores should be stored securely in a manner consistent with chain-of-custody procedures. Typically, cores remain in the custody of field staff until sampling is completed and sample jars transported to the analytical laboratory (see SOPs for Surface Sediment Sampling).

CORE PROCESSING PROCEDURES

SEDIMENT CORE EXTRUSION

Cores should be split or extruded and processed within 24 hours of collection, either onboard the vessel or at an onshore sample processing facility. The sediment may be removed from the core tube by either extrusion or longitudinal sectioning (i.e., splitting). Extrusion is done by tilting the core tube until the sediment core slides out onto a clean, aluminum-foil-covered table or tray. Vibration or tapping of the core tube may aid extrusion. If the sediment core does not slide out easily, a plunger may be used to push the sediment out of the tube. The plunger should be cleaned and covered with clean aluminum foil each time it is used. Once the tube is extruded, a thin (0.25 to 0.5 cm) outer layer of the sediment core is scrapped away using a decontaminated, stainless-steel knife (see SOP for Surface Sediment Sampling. This outer material may be used for sediment grain-size determination if sediment volume is of concern, but should not be used for any chemical analyses.

In longitudinal core splitting, the core tube or liner is split with a circular saw to expose the sediment core, or the core material can be run across a splitting knife as it is extruded. If a core tube liner is used, care should be taken to scrap the surface of the sediment core to remove any shavings of liner material.

SEDIMENT SAMPLE PROCESSING

Regardless of how the sediment core is obtained and prepared, the procedures for record keeping, sediment processing and sampling techniques are as follows:

1. Immediately following core extrusion or splitting, collect samples for volatile compounds (either organics or sulfides) using a

decontaminated,stainless-steel spoon. The volatile organics sample jar should be tightly packed (to eliminate obvious air pockets) and filled so that there is no head-space remaining in the jar. Alternatively, if there is adequate water in the sediment, the container may be filled to overflowing so that a convex meniscus forms at the top, and the cap carefully placed on the jar. Once sealed, there should be no air bubbles. The sulfides sample is preserved with 0.2 N zinc acetate.

2. Record core sediment characteristics on a core description form (see attached). Observations should include stratification of color and sediment composition, odor, biological organisms, foreign objects etc.
3. Place remaining core sediment in a decontaminated, stainless-steel bowl (see SOP for Surface Sediment Sampling) and mix thoroughly with a stainless-steel spoon, spatula or mixer until uniform color and texture are achieved. Large rocks or wood pieces may be omitted from the final laboratory sample, but should be noted in the log or description form.
4. If sediment from multiple core sections will be composited, cover the bowl with clean foil and set the bowl aside (refrigerate or keep cool on ice) while handling additional cores. Once all the required sediment has been placed in the bowl, thoroughly mix until uniform color and texture are achieved.
5. Transfer aliquots of homogenized sediment to labeled sample containers provided by the analytical laboratory. Labels should include, at minimum, the company name, project name, sample identifier, date and time of collection, and the initials of sampling personnel.
6. Pack and transport samples as described in the SOP for Surface Sediment Sampling. If samples will be stored, follow procedures specified in the project sampling plan.

QUALITY CONTROL PROCEDURES

Field quality control (QC) samples that may be collected during sediment coring are the same as for any field sampling program. The types and frequency of field QC sample collection are project-specific and will be described in the field sampling plan. The most commonly collected field QC sample are described below (PSEP 1996):

- **Field Blank**. A field blank is a sample of analyte-free water that is supplied by the laboratory. The field blank is generated by transferring the analyte-free water to another laboratory-supplied sample container while at the field sampling location. Field blank results are used to measure and document any possible onsite contamination.

- **Field Split Sample**. A field split sample consists of aliquots of the same homogenized sediment sample that are equally distributed in two sets of sample containers. These samples may be analyzed identically or analyzed by different laboratories to evaluate repeatability of sample handling and analytical procedures, sample heterogeneity, and analytical procedures.

- **Field Replicate**. A field replicate consists of a second sample that is collected using the same sampling methodology used to obtain the first sample. It is collected at the same sampling location and as soon after the original sample as possible. Analysis of the field replicate allows evaluation of the repeatability of field sampling methodologies, as well as the heterogeneity of the sample matrix. Statistical analysis of multiple replicates may also be used to calculate the likely range of an analyte concentration at a given sampling location.

Additional types of QC samples are described in the SOP for Surface Sediment Sampling.

REFERENCES

PSEP. 1996. Puget Sound Estuary Program: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Prepared for U.S. Environmental Protection Agency, Region 10, and Puget Sound Estuary Program Seattle, WA. Tetra Tech and HRA, Inc., Bellevue, WA

APPENDIX B-3
STANDARD OPERATING PROCEDURE
HORIZONTAL AND VERTICAL SURVEY CONTROL

The methods and standards proposed in this Standard Operating Procedure (SOP) should be considered provisional and are subject to revision based on a two-week period associated with the initial sampling activities anticipated to begin on or about March 28, 2018. During this period, AECOM will work with project team member David Evans and Associates, Inc. (DEA) and their Oregon Professional Land Surveyor (PLS) staff to validate, methods, controls, and standards. United States Environmental Protection Agency (EPA) Region 10 will be debriefed on the outcome and consulted for approval of any changes or modifications to this SOP.

Introduction

This Standard Operating Procedure (SOP) has been developed for the Pre-Remedial Design Sampling and Baseline Investigations (PDI) at the Portland Harbor Superfund Site located in Portland, Oregon to confirm accurate positioning of vessels and samples during sample collection activities. The survey control requirements described in this SOP are specifically for environmental sample collection and will generally comply with map-grade precision and accuracy in contrast to the geodetic-grade precision and accuracy anticipated for the Bathymetric Survey conducted by DEA. However, the same survey control points and geodetic parameters will be used in both surveys for consistency, and a portion of the quality assurance/quality control (QA/QC) process will involve consultation with DEA PLS staff to review the map-grade data collected for the environmental sample collection.

The organization of remainder of this SOP is as follows:

- Methodology Overview
- Project Geodetic Parameters
- Survey Accuracy, Precision, and Control
- Primary Equipment
- Hand-Held GPS Operation
- Vessel Navigation and Equipment Operation
- Data Processing and QA/QC Procedures

Tables, figures, and attachments are presented at the end of the SOP.

Methodology Overview

Horizontal (Map) Data Collection

A combination of vessel-mounted and hand-held GPS receivers will be used to navigate to sampling locations and to collect map location coordinates (Northings, Eastings) for those sampling locations. The vessel-mounted GPS receivers will be the primary tool used for navigation to the pre-planned sampling locations recorded in georeferenced basemap which will be pre-loaded into the vessel navigational system. The hand-held GPS devices will be used as a backup and confirmation of vessel position; these devices will also have the pre-loaded basemap content depicting planned sampling locations.

The vessel GPS will operate in two modes, collecting both a separate continuous data stream of positional information (line file) and recording GPS soundings (target file) when a sample is specifically collected. The sample location target file will be recorded when the sampling device is in position for the grab (e.g., when sampler is on the river bottom). The specific Location ID associated with the sample will also be recorded in the GPS device log. Field personnel will be required to write that same Location ID on their field data collection forms at the same time. Both the continuous and episodic dataset will be timestamped to allow comparison of the two types of data. This data will be recorded and maintained on the vessel, and will also be exported from the vessel navigation system and archived to project servers on a daily basis.

The hand-held GPS devices will be operated independently of the vessel's systems and will be used to record a location sounding wherever a sample is collected. The sample location sounding will be recorded approximately at the same time as when the vessel GPS measurement is collected (e.g., when sampler is in position). The specific Location ID associated with the sample will also be recorded on the GPS device. Field personnel will write this Location ID on the field forms only if the vessel measurement described earlier cannot be collected for some reason (e.g., equipment failure). These measurements will also be timestamped in approximate synchronization with the vessel's time recording system. The data from the hand-held GPS devices will be wirelessly synchronized to a "cloud" web service in near real-time; the data from the "cloud" will also downloaded and saved to project servers daily.

Vertical Data Collection

Vertical (elevation) data is also required for water levels, sample collection depth below surface water, and bottom (mudline) depth location for some types of sample locations. For increased precision and accuracy, it is proposed that bottom (mudline) depth locations (e.g., for sediment cores) be calculated from the bathymetric surface to be developed by the hydrographic survey performed by DEA (since the data will be collected within a few months of each other). The NAVD88 elevation will be calculated from the intersection of the surface map location coordinates collected as described earlier, projected vertically down to the bathymetric surface (United States Army Corps of Engineers [USACE], 2004). The elevation from the intersection of the bathymetric surface will be used as the final or "best" elevation for the sample.

In contrast, for depth measurements that require less precision (e.g., water levels, depth to samples below water surface), the onboard vessel sonar will be used to record depth and then subsequently calculate elevation. All depths will be recorded relative to the water surface and time tagged to correct with time tagged gauge data for obtaining riverbed elevations. The elevation will be calculated to NAVD88 datum. To correct elevations, gauge data from the Northwest River Forecast Center will be downloaded for gauge PRT03, which is representative of the former Morrison gauge which has been moved. This gauge does not report NAVD88 elevations but rather reports a value that is 0.3 feet above

Columbia River Datum (CRD). Corrections from CRD to NAVD88 differ moving down the river from the gauge due to the fact that NAVD88 is a reference normal to gravity (water does not flow if the elevation is unchanging), and CRD is a gradient datum that follows the lower water surface. In Portland Harbor the difference between CRD and NAVD88 (Geoid12b) ranges from 0.00 feet CRD = -5.16 feet NAVD88 (Geoid12b) at Willamette river mile 2.0, to 0.00 feet CRD = -5.41 feet NAVD88 (Geoid12b) at Willamette river mile 12.8 (approximate location of PRT03 Gauge). Accordingly, a correction to the Willamette Gauge in Portland would be -5.41+0.3 or -5.11 feet at mile 12.8. An approximation would be to subtract 5 feet from the gauge reading for the full length of the study area, but precision will vary depending on tides and river gradient.

For sample locations requiring vertical information, depth will be recorded by field staff on their data collection forms relative to the water surface, and these values will be loaded to the project database as described in the Data Quality Management Plan (DQMP). Final calculated NAVD88 elevation data (feet) will also be entered into a separate data field in the project database after completion of spatial analysis, calculations, and QA/QC. DEA will provide support during the QA/QC process to verify proper calculation of NAVD88 elevation data.

Location Position Recording in Project Database

Discrete Samples

When discrete samples are collected, the Location ID and the location coordinates (Northing/Easting) will be recorded on the GPS device(s) and the field data collection form(s). The location coordinates will be based on the vessel GPS instantaneous target measurement. This target measurement will be the location coordinate pair loaded initially to the project database. After the field event is completed, the target measurement will be compared to the line file (vessel continuous GPS measurement) to confirm that the coordinate pair loaded to the project database is appropriate. If analysis reveals precision or accuracy issues, the loaded location coordinate pair in the project database may be updated and edited with a better value derived from the line file. In general, the hand-held GPS data will only be used as an independent cross-check of location coordinate information and will be loaded to the project database only if there is a significant problem with the vessel GPS (e.g., equipment failure).

Composite Samples

When composite samples are collected, location coordinates will also be recorded as both target measurements and continuous measurements using the vessel GPS. The continuous GPS measurements will be recorded during the entire composting event, and instantaneous target measurements will be collected when the sampler is in position for each individual composite grab. At each composting location, a target measurement will be recorded in the vessel GPS along with the Location ID with an "a," "b," or "c" suffix. These measurements will be recorded on the field forms in the same manner (e.g., there will be three sets of location coordinates, lithologic descriptions, etc.).

When the location data is loaded to the project database, a single set of location coordinates will be recorded in the project database with a Location ID that excludes the "a," "b," or "c" suffix. As a presumed middle time point, the "b" set of coordinates will be loaded with the primary Location ID to the project database. After the field event is completed, the target measurement associated with the “b” location composite will be compared to the line file (vessel continuous GPS measurement) to assess vessel position and the timeframe of the entire sampling event to confirm if the coordinate pair loaded to the project database is appropriate. The goal will be to finalize the location coordinate information in the project database based on the most representative position based on this analysis. Similar to discrete sample collection, the hand-held GPS data will be loaded to the project database only if there is a significant problem with operation of the vessel GPS.

Finally, after field data are collected and surveys are completed, as defined in the DQMP, the location coordinate data will be joined with the tabular data collected by the field teams and loaded to the project database.

Project Geodetic Parameters

The geodetic parameters to be used for the PDI field studies will be as follows:

Horizontal Datum: North American Datum of 1983 (2011)
Projection: State Plane Coordinate System (SPCS) Oregon North Zone
Vertical Datum: North American Vertical Datum of 1988 (NAVD88) Geoid12b
Units: International Feet

Survey Accuracy, Precision, and Control

The anticipated horizontal accuracy of environmental sampling associated with vessel and hand-held GPS devices is a range of 1 to 5 meters (target 1 to 2 meters for the DGPS unit itself). This should be consistent with RI target accuracy (Integral 2002) and best practices (Puget Sound Estuary Protocols [PSEP] 1998 and USEPA 2008).

The anticipated vertical accuracy of final elevation calculations derived from vessel sonar systems is anticipated to be 1.0 meter.

Table 1 summarizes the survey control locations used in the DEA Bathymetric Survey, which will be used for the environment sample collection work described in this SOP. Figure 1 shows the approximate locations of the survey control references. Attachment 1 contains detailed survey sheets of the control points: Raindeer, PH1, and 2100.

Primary Equipment

- Trimble® 461 GPS with dual antennas (vessel GPS)
- A-frame assembly, sampling winch (vessel boom)
- Trimble® R1 (hand held GPS), tethered to Bluetooth® capable smartphone or tablet, ESRI Collector software with Trimble® GNSS Status middleware
- GPS owner’s manual
- Writing tools (pencils, Sharpie®)

- Field logbook
- Spare batteries and/or battery charger
- Compass
- Tape measure

Hand-Held GPS Operations

For ease of use, the project team will utilize smartphones tethered to the Trimble® R1 GNSS Receiver via a Bluetooth® connection. The smartphone will be configured with Trimble's middleware software called GNSS Status to convert and stream NMEA satellite data to the smartphone for real-time correction and display to a simple electronic data collection form developed on the ESRI Collector platform. The form will contain a pre-loaded list of valid Locations IDs associated with all the sampling studies, and a limited number of other data fields including study name and operator. This form is not intended to duplicate the content and scope of the field data collection forms, but rather clearly link the GPS data to those forms via the unique Location ID.

Collected data will be recorded onto the phone and transmitted wirelessly via a synchronization process invoked when data is "saved" to the device. The data will be pushed to AECOM Online's Portal and ArcGIS Server for storage of "corrected" location coordinates, Location ID, and other information captured when the GPS sounding is recorded. The sampling event will be trackable in near-real-time as samples are collected on the ArcGIS Portal Interface. Either dedicated, experienced GPS-operators will be collecting the measurements on the smartphones, or, due to the very simple nature of the interface, field personnel will be trained to use the devices. Initial training sessions were already successfully conducted March 19-20, 2018 on use of the smartphone GPS interface.

Vessel Navigation and Equipment Operation

Vessel positioning will be conducted through the marine navigation and hydrographic software package HYPACK. This software package allows the visualization of the vessel over navigable charts, the processing of satellite corrections, stored hardware, and vessel parameters, as well as the storing of physical target locations during sampling activities. HYPACK version 2017 will be used for this project.

Vessel position is measured using a Trimble 461 GPS with dual antennas. The dual antennas provide precise vessel positioning via both satellite and differential radio corrections along with heading correction to 0.1 degree. GPS data is output through a serial connection into computer running the HYPACK software, for vessel positioning and target collection.

At each sampling location, depth to mudline will be measured using an onboard fathometer (with lead line as confirmation as needed) immediately prior to or during the sampling. Water depths are measured at each station using an Airmar ss510 survey sonar at the sampling point and confirmed daily with a lead line with reference to water surface. Vertical measurements will be recorded to the nearest 0.1 foot. Water depths will be converted to elevations in NAVD88 based on the river stage at the time of sampling as recorded at the closest available tide gage.

Data Processing and QA/QC Procedures

All GPS systems will perform a position check to confirm the accuracy of the on-vessel GPS and hand-held GPS devices and validate the positions derived from each GPS receiver. Correctors being applied as needed, resulting in a position that is within specified positioning accuracy of the DEA published position for control monument PH-1. At the start and end of each field day, the PH-1 benchmark location will be visited to perform a position check. At the control monument, the on-vessel GPS mounted to the top of A-frame assembly will be maneuvered over the survey monument. The GPS-derived position of the sampling vessel is compared with the known horizontal location; results will be recorded in the field notebook to confirm that accuracy is within +/- 2 meters. If the GPS cannot be placed on the benchmark location directly, then field staff will record the distance and compass direction to the location as an "offset." The survey control monuments act as a known location to allow for corrected station location coordinates during post-processing of data as needed. Experienced GPS operators on the project team will be involved in all aspects of field data collection events to troubleshoot devices and assist in daily review of extracted geospatial datasets. Additional details on QA/QC procedures can be found on the DQMP.

References

AECOM (AECOM Technical Services) and Geosyntec (Geosyntec Consultants, Inc.). 2018. Data Quality Management Plan Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling. Portland Harbor Superfund Site. 22 February.

Integral (Integral Consulting). 2002. Round 1 Field Sampling Plan. Prepared for the Lower Willamette Group (LWG) for submittal and approval by EPA Region 10. June 14.

EPA (United States Environmental Protection Agency). 2008. National Geospatial Data Policy. August 24.

PSEP. 1998. Recommended Guidelines for Station Positioning in Puget Sound. Prepared for United States EPA Region 10 and the Puget Sound Water Quality Action Team. September.

USACE (United States Army Corps of Engineers). 2004. Engineering and Design Hydrographic Surveying Manual, EM 1110-2-1003, U.S. Army Corps of Engineers, April 2004

Attachments

PH Control Points of 2100, Portland Harbor (PH1), and Raindeer survey monuments

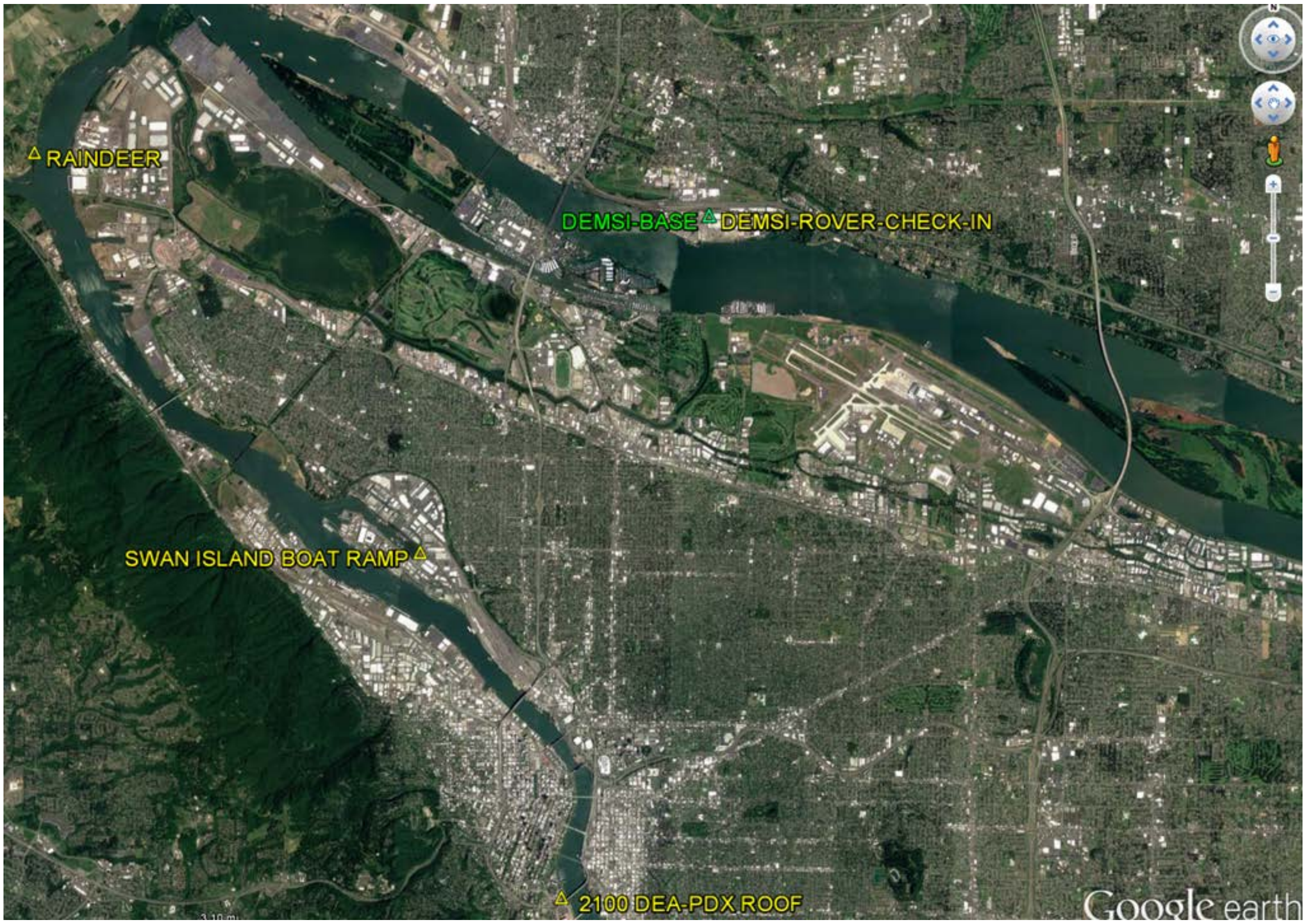
Table 1. Benchmark Monument Coordinates and Description

Designation	Approx. Location	Description	NAD83, Oregon SPCS North (ft)		NAVD88 Elevation (ft)
			Northing	Easting	
DEMSI-BASE	Columbia River	Fixed antenna with height at antenna reference point	718172.70	7654431.05	73.58
DEMSI- CHECK	Columbia River	Fixed antenna with height at antenna reference point	718170.73	7654419.84	71.67
RAINDEER	RM 2	USACE Brass Cap	722443.24	7614886.64	35.44
Portland Harbor (PH1)	Swan Island Boat Ramp	1/2" Iron Rod with red plastic cap stamped "DEA Control" Point is 0.3' south of the back of curb at the Swan Island Boat Ramp, 10.5 feet north of a cyclone fence, and 60' east of a light post	698702.46	7637426.37	33.38
2100	RM 13	5/8" bolt on SW corner of screen wall at DEA office 2100 SW River Parkway, Portland, OR	678400.01	7645190.81	159.51

General Notes:

1. The two DEMSI and the 2100 stations are transceiver beacon stations in upland areas (Green Shade).
2. PHI is located at the Swan Island boat ramp and accessible by boat.
3. Raindeer station is located adjacent to the river and access by foot (for the hand-held GPS).

Figure 1. Approximate Survey Control Monument Locations



APPENDIX B-4 – Round 2 FSP Excerpt from PID Field Screening (Integral 2004)

Except for sample volumes collected for volatile analytes, sediment from each subsample will be individually mixed in the decontaminated, stainless-steel bowl to a uniform color and texture using a decontaminated, stainless-steel spoon. The sediment will be stirred periodically while individual samples are taken to ensure that the mixture remains homogeneous. Care will be taken to not include sediment that is in direct contact with the aluminum tube. In addition, the cutting of the aluminum tube can introduce metal shavings to the core sediment. Care will also be taken to avoid mixing these shavings into the homogenate. Pre-labeled jars for chemical testing will be filled with the homogenized sediment.

The types and number of field QC samples for subsurface sediment samples will follow the same guidelines prescribed for surface sediment samples. If additional volumes of sediment are required to perform all analyses in addition to QC analyses, an additional core may need to be collected from the same location and subsampled and homogenized accordingly.

Sample handling and storage procedures will follow those described for surface sediment samples in Section 4.6.1 with the following exception. When required, sediment subsamples for volatile organics will be collected from within appropriate intervals following the opening of the core and designation of the lithologic units. This process will minimize the release of volatile organics caused by mixing. Rinsate blanks will be performed at the same frequency (5%) as performed for the surface sediment sampling program.

4.6.4 Subsurface Sediment Sample Field Screening

In addition to visual observation, headspace screening using a photoionization detector (PID) and/or flame ionization detector (FID) may be used on all sample intervals to aid in the selection of samples to be analyzed.

Headspace Screening

Headspace screening involves the semi-quantitative measurement of total volatile compounds in the air above the sample material. Headspace concentrations will be measured using the following procedure.

1. A small representative sample will be collected from each sample interval to be screened using a decontaminated sampling spoon. The material will be placed in a resealable plastic bag or glass jar with a septum lid.

2. The bag or jar will be tightly sealed (the jar with aluminum foil and plastic lid with septum opening), and the material will be allowed to warm at least to the ambient temperature (>32^{o} F). The sample will be allowed to sit for at least 10 to no more than 60 minutes to allow headspace concentrations to develop, and shaken

periodically for at least 30 seconds at the beginning and end of the development period.

3. The PID/FID probe tip will be inserted into the container within the headspace, with care taken to avoid taking sediment or moisture into the probe.

4. The highest reading (excluding possible erratic readings) on the meter will be recorded for the sample.

5. The deepest sample interval showing a response during headspace screening will be submitted in the initial round of analyses.

4.7 WASTE DISPOSAL

Any excess water or sediment remaining after processing will be returned to the river in the vicinity of the collection site. Any water or sediment spilled on the deck of the sampling vessel will be washed into the surface waters at the collection site before proceeding to the next station.

All disposable materials used in sample processing, such as paper towels and disposable coveralls and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill. Phosphate-free, detergent-bearing, liquid wastes from decontamination of the sampling equipment will be washed overboard or disposed of into the sanitary sewer system. Waste solvent rinses will be held in sealed plastic buckets and disposed of into the sanitary sewer. Oily or other obviously contaminated investigation-derived waste will be placed in appropriate containers, and a waste determination will be made before it is disposed of at an appropriate facility.

4.8 SAMPLE HANDLING AND TRANSPORT

Since samples collected in support of CERCLA activities may be used in litigation, their possession must be traceable from the time of sample collection through laboratory and data analysis to introduction as evidence. To ensure samples are traceable, the following procedures will be followed.

4.8.1 Chain-Of-Custody Procedures

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. A chain-of-custody record will be signed by each person who has custody of the samples

APPENDIX B-5

STANDARD OPERATING PROCEDURE
MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Introduction

Investigation derived wastes (IDW) generated during the Pre-Remedial Design Investigations at the Portland Harbor Superfund Site may include:

- Soils/sediments
- Surface water
- Other materials:
    - Personal protective equipment
    - Disposable sampling equipment
    - Spent decontamination liquids
    - Plastic sheeting, containers, etc.

The management of these wastes will be conducted to limit exposure of Site personnel to hazardous materials, and to prevent introduction of contaminated materials to uncontaminated environmental media at the Site (soils, sediment). The following Standard Operating Procedures (SOPs) establish protocols for testing, storage, and disposal of these materials.

Disposal of laboratory test equipment and supplies will be handled in accordance with the laboratory Quality Assurance Project Plan (QAPP).

General

IDW management will follow guidance described in the Office of Solid Waste and Emergency Response (OSWER) document, Guide to Management of Investigation-Derived Wastes (United States Environmental Protection Agency [EPA] 1992). This guidance discusses factors to consider as part of an IDW management program. These factors include protectiveness of human health and the environment, compliance with applicable and relevant or appropriate requirement (ARAR)-based cleanup levels, land disposal restrictions, storage requirements, recordkeeping and manifesting, and handling of non- Resource Conservation and Recovery Act (RCRA) hazardous wastes. The IDW management program described in this section incorporates these factors in the program.

All IDW identified as potentially contaminated with hazardous materials will be stored in a designated and clearly marked IDW management area located at the AECOM Technical Services (AECOM) Field Laboratory. All vessels will also be clearly labeled to indicate the source of the IDW. The IDW storage area will be inspected daily to ensure that storage procedures (as outlined below) are being followed. Any violations of these procedures will be documented and remedied as quickly as possible. Potentially contaminated IDW will be identified based on its origin, olfactory evidence, and visual evidence. Laboratory testing will be required to determine the proper disposition of these IDW.

Media Specific IDW Management

Sediment/Soils

Waste soils and sediments will be generated as excess sample material. The required testing and handling of this IDW will depend on its origin and characteristics. Olfactory and visual observations will be used to determine if the soils contain potentially elevated levels of hazardous materials. The amount of sediment generated will be minimized to the volume necessary for sampling and analysis, if possible. During field operations, leftover sediment material will be returned to the location it was generated from unless a significant sheen or non-aqueous phase liquid (NAPL) is observed. If significant sheen or NAPL is observed, sediment on the vessel or laboratory processing area will be temporally stored in 5-gallon buckets with lids, then transferred to 55-gallon drums. Each drum will be labeled using a grease pencil or paint pen to indicate the date sealed, location, and contents. Each of the sealed drums will then be staged at a designated solid waste management unit location for later disposal characterization.

Surface Water

Sampling activities may result in the creation of surface water sheens. Sorbent booms will be deployed if significant sheen is encountered on the water surface during coring/grab sampling. A small support boat may be used to manage the boom so the sampling vessel can operate without interruption. AECOM will coordinate with the Office of Spill Prevention Section on additional mitigation measures and agency notifications for releases. Surface water generated during sediment collection will be returned to the lake unless a significant sheen is observed. If a sheen is observed, water will be contained in 55-gallon drums or plastic containers and managed accordingly.

Personal Protective Equipment (PPE)

Investigation-derived PPE consists of gloves, chemically protective clothing, respirator canisters, and other one-time use equipment used during the field investigation. All used PPE will be containerized in plastic garbage bags and disposed of on-site for subsequent transport to the municipal landfill.

Decontamination Fluids

Decontamination fluids will be drummed up in either 55-gallon drums or disposed of in sanitary sewers if no significant sheen is observed. Alconox used on the boat will be discarded overboard if no significant sheen is observed. The decontamination containers will be kept on-site until the water has been analyzed for hazardous materials, at which time the water will be discarded appropriately.

Chemical Liquid Wastes

Chemical liquid wastes will include the spent solvents and acids and other residual chemicals generated during the decontamination process.

Waste acids and solvents will be collected in (dedicated) satellite containers as follows:

- Waste acids (e.g., hydrogen chloride, nitric acid) will be collected in a plastic storage carboy (20-L) SEPARATE FROM WASTE SOLVENTS, labeled with a Class 8 Corrosive Liquid label and containing a tag that indicates acid name, concentration, and volume along with users' initials and date/time.
- Waste solvents (e.g., acetone, methanol, and hexane) will be collected in Type I or II UL-approved galvanized steel disposal can, SEPARATE FROM WASTE ACIDS, labeled with a Class 3 Flammable Liquid label and containing a tag that indicates solvent name, concentration, and volume along with users' initials and date/time.

Solvent Waste (Acetone, Methanol, Hexane)

- Assign a unique identification number to the Type I or II UL-approved steel disposal can (clearly marked on the top and sides).
- Prepare a log for the drum, listing the volume and concentration of each solvent transferred to the drum along with date/time.
- Place a label indicating that the drum contains IDW pending characterization and a Class 3 Flammable Liquid label on the drum.
- Close the drum after each transfer.
- Store the drum in a secure area at the field facility until pickup by an authorized waste handler at the end of the field phase. Drums containing hazardous waste will be removed from the facility within the time mandated for the governing hazardous waste generator status (large quantity generator, small quantity generator, or conditionally except generator).

Other Materials

All plastic sheeting, sampling containers, and other disposable equipment that is free from hazardous materials will be containerized in plastic garbage bags and disposed of on-site for subsequent transport to the municipal landfill. Materials that have visible NAPL will also be drummed and shipped off-site for disposal at an approved facility. Non-disposable or bulky materials may be decontaminated and re-used or disposed as solid waste (see SOP for decontamination). Other disposable materials used on-site (tarps covering non-contaminated soils, caution tape, potable water containers) that have not contacted contaminated media will be disposed as solid waste.

Testing and Disposal

All drummed materials will be tested to determine the proper disposal method. Composite samples will be collected from each drum for analysis. Composite samples will be collected such that reasonable likelihood exists that the entire volume of material in a drum is represented in the sample.

Composite samples will be tested for the parameters identified in the QAPP. Modifications of this analyte list may be made based on specific knowledge of the origin and likely contaminants in the materials.

Soils contaminated above hazardous waste criteria will be shipped to a licensed disposal facility following any further required waste characterization or stabilization.

References

United States Environmental Protection Agency (EPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Solid Waste and Emergency Response. 9345-03FS.

AECOM
111 SW Columbia Avenue
Suite 1500
Portland
OR, 97217
USA
aecom.com

Geosyntec
520 Pike Street
Suite 1375
Seattle
WA, 98101
USA
geosyntec.com